SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY, 1931.

GENERAL PHYSICS.

1433. Prism Derivator and the Differentio-Integraph. E. v. Harbou. *Zeits. f. angew. Math. u. Mechanik*, 10. *pp.* 563–585, *Nov.*–
y for the evaluation of
able which supplies the
d acceleration can then
arise from the width of
style and friction in its
d for this purpose are
eory of action of the
together with improvements and refinements. The use of the differentio-integraph for differentiation and integration is explained. A critical review of the general properties of the apparatus is given, and a comparison is made experimentally with earlier types of mechanical integrators and differentiators. Finally, a series of experimental results is supplied. R. S. R.

ERRATUM

Section A.—PHYSICS.

Abstract No. 738, line 1; *for* W. Wataghin *read* G. Wataghin.

1434. Differential Manometer for High Pressures. J. H. Boyd, Jr. *Am. Chem. Soc., J.* 52. *pp.* 5102–5106, *Dec.*, 1930.—A manometer has been developed which is capable of measuring by electrical means pressure differentials of an inch of mercury with an accuracy of 1 part in 1000 at a pressure of 3000 lbs. per sq. in. The instrument is direct reading and requires neither calibration nor the use of very clean mercury. AUTHOR.

1435. Reality of the Neumann Triangle. N. Fuchs. *Zeits. f. Physik*, 65. 9–10. *pp.* 714–718, 1930.—The objections raised against the reality of the Neumann principle are unsound, and its validity is now demonstrated experimentally. H. H. Ho.

1436. Surface Tension in the Magnetic Field. H. Auer. *Zeits. f. Physik*, 66. 3–4. *pp.* 224–228, 1930.—Experimental arrangements are described having a maximum sensitiveness of 6×10^{-7} for establishing the inalterability of the surface tension in the magnetic field. The substances examined were water, alcohol and certain paramagnetic salt solutions, such as aqueous iron and cobalt chloride of different concentrations, under a magnetic field of 20,000 gauss. H. H. Ho.

1437. Measurement of Surface Tension. M. Chopin. *Comptes Rendus*, 191. *pp.* 1293–1295, *Dec.* 30, 1930.—Describes apparatus suitable for measuring the surface tension of small quantities of liquid, such as sap or latex. The base supports a horizontal ring-shaped knife edge, projecting upward, while a slightly larger ring-shaped knife edge, pointing downward, is suspended above it, concentrically, from the arm of a balance. The lower knife edge is moistened with the liquid, and the upper knife edge dips into it. If weights are placed in the pan carried by the other arm of the balance, the upper ring is raised, so as to form a more or less cylindrical film between the two ring-shaped knife edges. Practically, the adjustment can be made by attaching to the other arm of the balance a long thin rod of glass which dips into a liquid, and this is gradually allowed to run out of the containing vessel until the beam is in the correct position. H. N. A.

1438. Distribution of Velocity in an Open Channel of Rectangular Section. T. B. Abell and J. H. Lamble. *Roy. Soc., Proc.* 130. *pp.* 90–97, *Dec.* 2, 1930.—The work described in this paper is based on the actual calibration of a hydraulic channel recently completed at the University of Liverpool. The immediate object of the calibration was to explore the central portion of the stream and to obtain the limits of the area of cross-section over which the velocity of flow parallel to the channel might be regarded as sensibly uniform. Measurements of velocity were made at a range of levels and also at a series of verticals in the same transverse plane. A complete mapping has also been undertaken of the contours of constant axial velocity. The apparatus is described in detail and the paper well illustrated by diagrams. The slowing-up of the streams at the centre at the bottom suggests a cause for the formation of mid-river banks observed in some river beds. H. H. Ho.

1439. Irrotational Motion of a Compressible Inviscid Fluid. H. Bateman. *Nat. Acad. Sci., Proc.* 16. *pp.* 816–825, *Dec.*, 1930.—This entirely mathematical paper deals with the subject under the following headings: variational principles; spiral flow; motion with velocity greater than the local velocity of sound; circulation round an aerofoil; effect of varying the function $f(\rho)$ of the density ρ of the fluid. H. H. Ho.

1440. Compressibility of Nitrogen and Hydrogen at High Pressures up to 5000 Atmospheres. J. Basset and R. Dupinay. *Comptes Rendus*, 191. *pp.* 1295–1297, *Dec.* 22, 1930—The following table gives the volume at 16° C. of 1 l. of gas measured at N.T.P.:

Pressure (kg./cm.^{2})	1000	2000	3000	4000	5000
Hydrogen (cm.^{3})	1·776	1·222	0·995	0·880	0·810
Nitrogen (cm.^{3})	2·130	1·660	1·470	1·350	1·305

The powers of the compressors necessary to compress nitrogen to different pressures are as follows:

Compression (kg./cm.^{2})	1 to 20	1 to 200	1 to 1000	1 to 5000
Power	1	1·78	2·19	2·72

The results for hydrogen agree with those which Amagat obtained up to 3000 kg. per cm.^{2} For nitrogen they are 2 to 3 % lower than Amagat's. The experiments were carried out with the apparatus previously described [see Abstract 1064 (1931)]. The volume of the gases at 5000 kg. is four to seven times that calculated by Boyle's law, but the power required remains sensibly a logarithmic function of the pressure. Higher pressures are being experimented with. H. N. A.

1441. Torsion Problem of the Theory of Elasticity. N. M. Basu. *Phil. Mag.* 10. *pp.* 896–904, *Nov.*, 1930.—The solution of the torsion problem of the theory of elasticity consists in the determination of a function called the torsion function, which at all inner points of a plane area satisfies the potential equation, while the outward normal derivative of the boundary is given in terms of the direction cosines of the outward drawn normal. The usual method consists in solving the boundary value problem for the conjugate function, but this is not easy to construct, except for one or more simple curves for the boundary. The author shows how the method of the calculus of variations leads to a direct determination of the torsion function which is applicable to wide classes of problems, and is specially suitable for numerical computations. [See also Abstract 1074 (1931).] R. S. R.

1442. Determination of Elastic Constants. G. Berndt. *Zeits. f. Instrumentenk.* 50. *pp.* 624–638, *Nov., and pp.* 679–692, *Dec.*, 1930.—Investigates the various sources of error, and the precautions required, in using the Marten mirror apparatus for determining the change in length of the rod under investigation; and a modification of the Sieglerschmidt apparatus for determining the alteration in its thickness. Measurements have been made on a number of steel specimens of different composition, the method of hardening and the Brinell hardness of each of which is recorded. The moduli of elasticity and Poisson's ratio m have been determined; the mean value for the latter is 0·27. The author concludes that the deviation from theory observed by Bochmann, in the value of the factor C in the H. Hertz equation, $M = C\theta^{\frac{2}{3}}$, for the flattening M due to pressure of bodies bounded by curved surfaces, really exists. $\theta = 4(1 - m^2)/E$. Bochmann found that C is 9·5 % smaller than the theoretical value for hardened steel, such as that used for ball-bearings; the author finds that it is 10·5 % smaller. H. N. A.

1443. Elastic Extension of Metal Wires under Longitudinal Stress. Part I. New Method for Measuring the Deviation from Hooke's Law. L. C. Tyte. *Phil. Mag.* 10. *pp.* 1043–1052, *Dec.*, 1930.—The method used was devised by C. H. Lees. Two wires are used of the same sectional area and the same material, one twice the length of the other, the stretching force on the shorter being double that on the longer. If Hooke's law were strictly true, both wires would extend equally. The lower ends of the two wires were in contact with an optical lever, which hung from them, by means of knife edges; the stretching weight was carried on the lever by means of a knife edge, in such a position that the force acting on the short wire was twice that on the long one. The long wire was supported at the top from a beam, and the short wire by a stout vertical rod which was also attached to the beam, so that the two wires were parallel and the optical lever was horizontal. The reflection of an illuminated scale in the mirror of the optical lever was observed in a telescope. Observations have been made on a large number of metals.
H. N. A.

1444. Coupled Oscillations. A Mechanical Model and Physical Theory. W. Stockmann. *Phys. Zeits.* 31. *pp.* 939–943, *Nov.* 1, 1930.—This work continues an earlier investigation on elastic oscillations in which a simple model was described consisting of a movable mass between two stretched springs and from which mathematical deductions were made, in particular that the mass oscillates according to the sum of the elasticities of the springs. A similar apparatus is now described with two masses, whereby coupled oscillations are studied both theoretically and experimentally, the conclusions being in agreement and of physical significance. H. H. Ho.

1445. Photoelasticity. E. Volterra. *Ingegnere,* 4. *pp.* 816–827, *Dec.,* 1930.—Gives examples of the application of Coker's polarised light apparatus for measuring the changes of thickness of a lamina of metal under mechanical stress. E. E. F. d'A.

1446. Mutual Transference of Torsional and Pendulous Oscillations. G. Subrahmaniam. *Phil. Mag.* 10. *pp.* 1095–1099, *Dec.,* 1930.—The transference of energy from the torsional to the "pendulous" form and back again, when the suspension of a torsion pendulum is attached to the bob at a point not on one axis, is studied in detail by means of the principle of moving axes, using Eulerian angular coordinates. J. H. A.

1447. Resistance of Shield Plates to Penetration by a Rifle Bullet. K. Honda, G. Takemaé and T. Watanabe. *Tohoku Univ., Sci. Reports,* 19. 6. *pp.* 703–725, *Dec.,* 1930. *Report No.* 257 *of the Research Inst. for Iron, Steel and Other Metals.*—A simple, mechanical and accurate method for determining the velocity of the bullet was devised, by which its velocity after passing through test-plates of different thicknesses was measured. In this manner the residual velocity *versus* plate thickness curve for different metals was obtained. This curve, which is called the "characteristic curve" of the shielding efficiency of a metal, was obtained for different metals and alloys. The curve not only gives the residual velocity of a bullet after passing through a shield plate of a given thickness, but also the thickness of the metal plate which is just sufficient to stop the impinging bullet, or the "penetration distance." The best material found as the result of the present investigation is a special steel, the penetration distance of which is 4·5 mm. for a bullet 9 gm. in mass and of a velocity 790 m. per sec. The penetration distance of laminated plates and of two plates of equal thickness separated from each other by a distance was also measured. The same quantity for wood, sand and glass of different kinds was also determined. AUTHORS.

1448. Exterior Ballistics of the Arrow. F. L. English. *Frank. Inst., J.* 210. *pp.* 805–819, *Dec.,* 1930.—A system of equations has been established describing the salient points of arrow ballistics. Values calculated from these formulæ check experimental determinations within approximately ± 1 %, which represents about the limiting accuracy of such determinations, since they are affected not only by the rather high errors inherent in wooden equipment but also, in the outdoor shooting, by very small variations in wind velocity. For example, a wind of one mile per hour is sufficient to account for an error of nearly 10 ft. in a range of 600 ft., or 1·7 %. It is probable that these equations would apply equally well, with suitable change in constants, to other types of low-velocity projectiles, and it is possible that a slight modification might adapt them to the ballistics of higher velocities. AUTHOR.

1449. Appell's Equations. R. J. Seeger. *Washington Acad. Sci., J.* 20. *pp.* 481–484, *Dec.* 4, 1930.—Gibbs has remedied defects in the standard equations of motion by the postulation of a formula involving

" geometric " accelerations instead of the ordinary " geometric " displacements, and has shown his expression to be a more complete and accurate description of the laws of motion. The present paper shows that Appell's equations, which describe the motion of a dynamic system with the advantages of applicability to both holonomic and non-holonomic systems (such as do or do not have integrable relations connecting the coordinate-velocities) and immediate expressibility in terms of accelerations, can be derived on such a basis. The relativistic form of the equations on the special theory is given. H. H. Ho.

1450. Determination of the Forces of Reaction in the Movement of a Material System. E. Gugino. *Comptes Rendus*, 191. *pp*. 1118–1121, *Dec*. 8, 1930.—The equations of Lagrange (second form), and those of Appell or of Maggi, completely define the motions of the systems concerned under the action of given forces, the connections being supposed without friction. They do not, however, include the reactions due to the connections acting on the different material points of the systems; they are eliminated entirely by means of the principle of virtual work. In many technical questions these reactions are of the greatest importance, and their study forms a special branch of mechanics, known sometimes as kinetostatics. The author shows that it is possible to arrive at a characterisation of the reactions without solving the problem of the motion of the system. The method of matrices is employed. H. N. A.

1451. Fourier Series and Interpretation of X-Ray Data. A. L. Patterson. *Zeits. f. Krist.* 76. 3. *pp*. 177–200, *Dec*., 1930. *In English*.—In Part I the three-dimensional Fourier series is discussed in its application to an array of scattering centres, after which the author deals with one- and two-dimensional aspects. The so-called " smearing out " of apparent structures is described, and it appears that a close similarity exists with the effects recently investigated by Bragg and West [see Abstract 1083 (1931)]. It is pointed out that X-rays cannot give more than a time-average structure, unless reinforced by a knowledge of the lattice mechanics at the temperature in question. In Part II a rigorous generalisation of Bragg's " enhancement principle " is obtained. In problems of this character it is shown that much information of a structural nature can be obtained without knowing the phases. F. I. G. R.

1452. Stereochemistry of Crystalline Compounds. Part IV. Atom Spacings in the Crystals. P. Niggli. *Zeits. f. Krist.* 76. 3. *pp*. 235–251, *Dec*., 1930.—Application of the symmetry principle previously developed [see Abstract 721 (1931)] allows of the prediction of the preferred ideal structure planes of crystalline compounds. Comparison of the atomic distances of different orders renders possible a classification of these crystal types. Within the limits of variation, the spatial relations are determined by the nature of the atoms concerned in a crystalline compound, the structural plan, often capable of deformation, being thus indicated. T. H. P.

1453. Dehydration of Heulandite. J. Wyart. *Comptes Rendus*, 191. *pp*. 1343–1346, *Dec*. 22, 1930.—This monoclinic zeolite loses water continuously on heating, and reabsorbs it when returning to normal temperatures. X-ray analysis indicates a slight contraction of the lattice up to 210°, and thereafter a stronger contraction. The crystal becomes discontinuous, corresponding to the experiences of other workers on dehydrated mica and kaolinite. F. I. G. R.

1454. Possible Orientation of Cubic Crystals on a Mica Flake. L. Royer. *Comptes Rendus*, 191. *pp.* 1346–1348, *Dec.* 22, 1930.—It is known that members of the alkali halides are mutually orientated on mica if the parameter of the (111) face lies between 4·43 and 5·64 Å. Recently, a series of phosphohexafluorides of the general formula RPF_6 have been prepared, with R = K, Am, Rb and Cs. The structure is cubic, but the details are unknown. Orientation occurs on mica, and from this fact it is inferred that the lattice is like that of rock-salt with the complex ion PF_6 in place of the simple anion. The following values for the (111) face are deduced: KPF_6 = 5·49 Å.; $RbPF_6$ = 5·64 Å.; $AmPF_6$ = 5·59 Å.; $CsPF_6$ = 5·80 Å. The "tolerance" for the Cs salt is discussed. F. I. G. R.

1455. Polymorphism of Fatty Acids. F. D. la Tour. *Comptes Rendus*, 191. *pp.* 1348–1350, *Dec.* 22, 1930.—An extension of previous work [see Abstract 3930 (1930)]. There are two forms of succinic acid, with a transformation temperature of about 137°. If β is the low-temperature polymorph, then on approaching 137° it ceases to be transparent and passes over into a white opaque condition without losing its crystalline form. This the author calls the α modification. The X-ray data are as follows:

	a	*b*	*c*	Volume.
α	5·03 Å.	8·75 Å.	7·48 Å.	240 Å.^{3}
β	5·04 Å.	7·58 Å.	9·75 Å.	238 Å.^{3}

The β form is triclinic pinacoidal, whereas α is monoclinic prismatic. The elementary cell in both cases contains two molecules of the acid. It is inferred that the axis of greatest density (that corresponding to COOH groups) is inclined in β and is horizontal in α. F. I. G. R.

1456. Crystal Structure of Fe_2B. G. Hägg. *Zeits. f. phys. Chem.* 11. *Abt. B.* 2–3. *pp.* 152–162, *Dec.*, 1930.—Fe_2B crystallises on a tetragonal body-centred lattice in the space group V_d^{11} with $4Fe_2B$ in the elementary cell. The iron atoms occupy the positions: m, m, p; $m, \bar{m}, p$; $m + \frac{1}{2}, m + \frac{1}{2}, p + \frac{1}{2}$; $m + \frac{1}{2}, \frac{1}{2} - m, p + \frac{1}{2}$; $\bar{m}, \bar{m}, p$; $\bar{m}, m, \bar{p}$; $\frac{1}{2} - m, \frac{1}{2} - m, p + \frac{1}{2}$; $\frac{1}{2} - m, m + \frac{1}{2}, \frac{1}{2} - p$. The parameter values are $m = \frac{1}{6}$ and $p = \frac{1}{4}$. The boron atoms occupy the positions: $\frac{1}{2}\,o\,o$; $\frac{1}{2}\,o\,\frac{1}{2}$; $o\,\frac{1}{2}\,o$; $o\,\frac{1}{2}\,\frac{1}{2}$. The iron atoms are accordingly at the corners of tetrahedra, forming a very symmetrical system. The boron atoms are situated in the largest spaces between these tetrahedra and are surrounded by eight iron atoms at equal distances. The structure gives the radius of the boron atom as 0·97 Å. A. J. M.

1457. Method for Growing Large Crystals of the Alkali Halides. J. Strong. *Phys. Rev.* 36. *pp.* 1663–1666, *Dec.* 1, 1930.—F. Stöber has specified four conditions which must be fulfilled in order to grow large crystals from fused salts. Ramsperger and Melvin [see Abstract 537 (1928)] in applying Stöber's method encountered difficulty. They were able to grow large crystals which, however, broke upon cooling on account of unequal temperature contraction of the crystal and the melting-pot, as well as on account of strains caused by unequal temperature contraction throughout the crystal. Two new supplementary conditions are specified which, together with Stöber's conditions, give a method for growing alkali halide crystals in cylindrical form 4·5 in. tall by 4·5 in. in diameter. AUTHOR.

1458. Application of Cylindrical Projection to the Solution of Crystallographic Problems. J. Leonhardt. *Zeits. f. Krist.* 76. 3. *pp.* 252–260, *Dec.*, 1930.—The principle of Mercator's projection is adapted to make it applicable to crystallographic uses. The etching of a rod-shaped tungsten crystal is worked out on these lines. T. H. P.

1459. Division of Planes in Working Ranges. F. Laves. *Zeits. f. Krist.* 76. 3. *pp.* 277–284, *Dec.*, 1930.—A topological investigation of the working ranges with particular reference to the space-group C_{2V}^{11}. Figures are given for triangular, quadrilateral, pentagonal and hexagonal ranges. Niggli's fundamental definition is accepted throughout.
F. I. G. R.

1460. Diffraction Phenomena with Molecular Radiation. O. Stern. *Phys. Zeits.* 31. *pp.* 953–955; *Disc.*, 955, *Nov.* 1, 1930. *Abstract of Paper read before the Deut. Physikertag., Königsberg, Sept.*, 1930.—Briefly examines results obtained by other authors, which indicate diffraction with molecular radiation. Young's type of diffraction is first considered, it being stated that each arrangement for the obtaining of a small molecular stream exhibits Young's diffraction conditions. Reflection from polished surfaces generally follows the cosine law, and results obtained previously by Knauer and Stern are summarised. Reflection at crystal cleavage surfaces, particularly LiF, are next considered, and, finally, diffraction at the crossed grating due to crystal cleavage surfaces is examined. The principal result obtained is that a normal gas radiation has the same wave properties as light radiation. [See also Abstracts 2102 and 2103 (1929).] R. C. F.

1461. Life of an Adsorbed Molecule and its Measurement from Studies of Molecular Streaming. P. Clausing. *Ann. d. Physik*, 7. 4. *pp.* 489–520, *Nov.* 20, *and* 7. 5. *pp.* 521–568, *Dec.* 3, 1930.—The various ways of defining the life of an adsorbed molecule are discussed. The author chooses as his definition the mean time τ_e during which all the molecules remain in the surface, irrespective of whether they suffer specular reflection or not. Knudsen's discussion of the molecular diffusion of gases through tubes at low pressures is extended to take account of the adsorption process. It is shown that τ_e is given by the expression $\tau_e = 2(2r/L)^2\bar{t} - 2r/u$, where r is the radius and L is the length of the tube through which the gas is diffusing, u is the mean molecular velocity, and $\bar{t}$ the mean time taken by a molecule to diffuse the length of the tube. This expression has been applied to the results of experiments on the rate of diffusion of argon, neon and nitrogen through glass tubes at low temperatures. In spite of extreme care, the results are not reproducible to a sufficient degree of accuracy except for the determination of the temperature coefficient of τ_e for argon on glass: $\tau_e \approx 1 \cdot 7\ 10^{-14}e^{3800/RT}$. This method for measuring τ_e may be applied to metals by stretching them axially in the form of a wire along the tube. This case is discussed.
F. J. W.

1462. Measurement of Molecular Velocity and a Proof of the Cosine Law. P. Clausing. *Ann. d. Physik*, 7. 5. *pp.* 569–578, *Dec.*, 1930.—In an earlier paper [see preceding Abstract] a formula has been developed for the mean time taken by a molecule to diffuse through a tube, under conditions such that the gas pressure is so low that no collisions occur in the gas phase. This formula has now been applied to the diffusion of argon and neon at room-temperatures, where the mean life of the adsorbed atom on the walls of the tube is negligibly small. The results obtained satisfy the equation under these simplified conditions, the agreement indicating that there is no specular reflection of argon and neon atoms at glass surfaces at ordinary temperatures. Further, the values of the mean molecular velocity as determined from this formula agree with those calculated from the Maxwell distribution law. F. J. W.

1463. Reflection and Time of Delay of Metallic Atoms on Oil Surfaces. G. Veszi. *Zeits. f. phys. Chem.* 11. *Abt. B.* 2–3. *pp.* 211–221, *Dec.*, 1930.—When an atomic beam has been directed against a solid surface, moving at right angles to the direction of the beam, in the hope of measuring a time-interval between the adsorption of the atoms by the surface and their re-emission from the same, it has been found that, when this time was at all long, the adsorbed atoms formed a deposit and the reflection ceased. v. Bogdandy and Polanyi have made use of rapidly moving oil surfaces to study the reflection of metallic atoms as, owing to the constant renewal of the oil surface, no deposits are formed on it. The author has used this method with Zn, Cd, Tl, Pb and Bi, the velocity of the oil surface at right angles to the atomic beam being about 15 m./sec. The atoms which flew back were caught on a cooled surface quite near to the oil surface, and distinct evidence was obtained in the cases of Zn, Cd and B, especially the last, that the atoms remained for a certain time on the oil surface before they were flung back. This time was of the order of magnitude 10^{-4} to 10^{-5} sec. H. N. A.

1464. Properties and Applications of Molecular Forces. F. London. *Zeits. f. phys. Chem.* 11. *Abt. B.* 2–3. *pp.* 222–251, *Dec.*, 1930.—Shows that the forces of attraction between molecules can be approximately deduced in a simple manner from the dispersion curve, *i.e.*, from purely optical data. These forces differ essentially from ordinary electrostatic forces, and from valency forces, in the fact that they give rise to a general additive attraction, and so are able to place the manifold forms of molecular attraction on a very simple, general, theoretical foundation, the conception of definite forces which are capable of superposition. Cohesion, the van der Waals forces in gases, heat of vaporisation, heat of adsorption, heat of sublimation of molecular lattices, energy of dissociation of molecules held together by van der Waals forces, can all be calculated from the same optical data, with an accuracy which lies between the limits fixed at present by the uncertainty of the empirical data employed and the lack of knowledge of the repulsive forces. H. N. A.

1465. Extended Energy Functions of the Hydrogen Molecule. P. M. Davidson and W. C. Price. *Roy. Soc., Proc.* 130. *pp.* 105–111, *Dec.* 2, 1930.—A formula giving the potential energy of a diatomic molecule and valid for all values of the distance between the two nuclei is worked out. The energy appears as the sum of two series each representing the potential of the mean effective force of one of the electrons on the nuclei, and also involves a term representing the potential due to the attraction between the nuclei. For the various states of the hydrogen molecule, the formula is shown to work satisfactorily even if only the first terms of the two series are taken. G. C. McV.

1466. Dualism between Corpuscles and Waves. E. Sevin. *Ann. Soc. Sci. de Bruxelles,* 50. *pp.* 121–134, *Dec.* 22, 1930.—The author argues that the diffraction of electrons by crystals does not support the hypotheses of wave mechanics. A wave need not be considered to exist before the electrons encounter the crystal; it is simpler to consider a classical wave as arising from the shock, analogous to those which are formed with the characteristic X-rays when a crowd of electrons strike an anti-kathode (continuous X-ray spectrum). On these lines the Compton phenomenon can be explained without recourse to photons. The Compton effect is reversible, and the wave shakes the electrons that it draws along and the electrons are disturbed by their shock on the crystal when the wave is formed. This affords a key to all the quantum phenomena. In a succeeding paper **C. Manneback** controverts the ideas of Sevin and considers that G. P. Thomson's experiment in which a photographic plate was used and the crystal replaced by a thin diffracting lamina is decisive. Other experiments are referred to, and specially the striking one of Compton and Simon. In a paper following that of Manneback a reply is given by **Sevin**, who supports his own views. J. J. S.

1467. Expression of Transition Probability. U. Doi. *Tokyo B.D., Sci. Reports, Sect. A.* 1. *pp.* 31–45, *Dec.* 20, 1930.—The statistical interpretation of the general solution of Schrödinger's wave equation involves the difficulty that if $\psi = \sum_n c_n \psi_n e^{\frac{2\pi i}{h}E_n t}$ is the linear combination of eigenfunctions representing the system, the intensity of a spectral line should be proportional to the number of atoms in the initial state, *i.e.*, to $|c_n|^2$, multiplied by the Einstein transition probability

$$A_{nm} = \frac{4(2\pi)^4}{3}\frac{e^2}{c^3}\frac{\nu_{nm}^3}{h}\{\int q\psi_n\psi_m^* dv\}^2,$$

and the relative intensities of two lines with the same initial state should be in the ratio $\nu_{nm}^4 q_{nm}^2 : \nu_{nk} q_{nk}^2$, where $q_{nm} = \int q\psi_n\psi_m^* dv$. This result leaves no variable to explain the observed effect of excitation conditions on such relative intensities. To avoid this and other difficulties, it is proposed to form the matrix χ with elements

$$a(n_1 m) = a_{nm}\left(\psi_n e^{\frac{2\pi i}{h}E_n t} + i\psi_m e^{\frac{2\pi i}{h}E_m t}\right)$$

normalised so that $\int \frac{1}{2} D(\chi\chi^*) dv = 1$, where $D(\chi_1\chi^*)$ denotes the diagonal sum of the matrices $\chi\chi^*$. The fluctuating electric moment generating the emission spectrum is then derived from the expression $\int eq\frac{1}{2}D(\chi\chi^*)dv$. It is adduced that the mean value of the energy emitted in the spectral line ν_{nm} becomes $\frac{4(2\pi)^4}{3}\frac{e^2}{c^3}|a_{nm}|^2\nu_{nm}^4 q_{nm}^2 (m < n)$, and the ratio of two spectral lines originating in the same level, is given by $|a_{nm}|^2\nu_{nm}^4 q_{nm}^2 : |a_{nk}|^2\nu_{nk}^4 q_{nk}^2$ The effect of excitation conditions can be allowed for in the choice of the coefficients a_{nm}. The values of the latter are determined for the case of a system consisting of harmonic oscillators in temperature equilibrium.

W. S. S.

1468. Solutions of Schrödinger's Equation when the Interaction Energy Possesses Singularities. G. Jaffé. *Zeits. f. Physik*, 66. 11–12. *pp.* 748–769, 1930.—It is shown by simple examples that when the interaction energy of two particles exhibits singularities, then, assuming ψ and its gradients to be continuous [see following Abstract], a far-reaching selection of permissible solutions may result. Considering two linear oscillators coupled with an energy function inversely proportional to the square of the distance apart of the particles (case of repulsion), solutions which pass adiabatically into symmetric solutions of the uncoupled problem are immediately ruled out, but symmetric and antisymmetric solutions of the coupled problem still remain. The additional assumption that solutions must pass continuously into those of the uncoupled system eliminates the former, and only antisymmetric solutions remain, in accordance with Pauli's principle. Two other examples (linear oscillators with coupling energy inversely proportional to the distance apart; three-dimensional oscillators) are discussed, and lead to analogous conclusions. Finally, the complication of spin is introduced by way of Pauli's theory. A coupling energy can be determined which results in the selection of solutions as required by the generalised Pauli principle, if the above-mentioned additional assumption is applied. The work aims at throwing light on the physical meaning of the Pauli principle. W. S. S.

1469. Conditions which Schrödinger's ψ Function Must Satisfy. G. Jaffé. *Zeits. f. Physik*, 66. 11–12. *pp.* 770–774, 1930.—Physical considerations are employed to deduce the mathematical restrictions to which the Schrödinger wave scalar must be subjected. The isolation of discrete quantum states with magnetic quantum number zero requires ψ to be finite. Conservation of particle number implies continuity of ψ and its first differential coefficient. That in certain cases singular solutions may have a physical meaning is shown by the quantum theory of radioactive disintegration, where at the origin the first differential coefficient of ψ is discontinuous and the particle number is not conserved. This corresponds to the physical interpretation that as radioactive disintegrations of a given element occur, further atoms of the element are formed by the disintegration of the parent element, and in effect there exists a steady source of α-particles. W. S. S.

1470. General Form of Dirac's Equations. R. Zaycoff. *Ann. d. Physik*, 7. 6. *pp.* 650–660, *Dec.* 9, 1930.—Develops a general relativity theory of the wave mechanics electron based on Dirac's wave equation for the electron. W. S. S.

1471. Dirac's Systems of Equations of Elliptical Type. G. C. Moisil. *Comptes Rendus*, 191. *pp.* 1292–1293, *Dec.* 22, 1930.—ψ_a is a system of $r = 2^k$ functions, and γ_i $(i = 1, \ldots, m)$ is a system of m matrices, with r lines and r columns, which satisfy Dirac's equations $\gamma_i\gamma_j + \gamma_j\gamma_i = 2\delta_{ij}e$. Considers the system of equations with partial derivatives $F\psi = \Psi$, where $F = \Sigma\gamma_i\frac{\partial}{\partial x_1}$, $F^2 = e\Delta$ and $\Delta\psi = F\Psi$. Obtains a system of integral equations, which is fundamental in the study of this system.

H. N. A.

1472. Introduction of Exchange into the Statistics of an Electron Gas. L. Goldstein. *Comptes Rendus,* 191. *pp.* 1306–1308, *Dec.* 22, 1930.—The statistics of bound electrons have been revised by Dirac to take into account the exchange energy, and he has concluded that in addition to its kinetic energy $E_k = \frac{p^2}{2m}$ there is an exchange energy $\frac{4e^2}{h}p$ for every electron which has the quantity of movement p. The author generalises this by saying that in every collection of electrons the total energy is composed of the classical kinetic and potential energy, and of the exchange energy; he works out a mathematical theory in view of this for an electron gas, and finds that in such a gas the energy of agitation is composed of kinetic energy of agitation and exchange energy of agitation. The latter may not perhaps always be of great practical importance, but it should be considered from the theoretical point of view. [See also Abstract 1093 (1931).] H. N. A.

1473. Michelson-Morley Experiment. G. Joos. *Ann. d. Physik,* 7. 4. *pp.* 385–407, *Nov.* 20, 1930.—A repetition of the Michelson-Morley experiment for detecting the velocity of the earth with respect to the ether, carried out in a cellar of the Zeiss works in Jena. The arms of the apparatus are of quartz, and 21 m. in length and monochromatic artificial light is used. The apparatus is described in detail and plates of the interference fringes are given. The result obtained is that the velocity of the earth with respect to the ether, if it exists, cannot be greater than 1·5 km./sec. G. C. McV.

1474. Symmetrical Analysis of Conical Order and its Relation to Time-Space Theory. A. A. Robb. *Roy. Soc., Proc.* 129. *pp.* 549–579, *Nov.* 3, 1930.—In a previous paper [*Cambridge Phil. Soc., Proc.* 24. pp, 357–374, July, 1928] the author pointed out that conical order, although it might be used to construct geometrics of n dimensions, will give $n - 1$ of these dimensions of one character and only 1 of the other. Thus in time-space theory, one of the terms for ds^2 is of different sign from the others. The fact that the ideas of congruence can be built up from purely ordinal considerations for time-space geometry seems to indicate a special importance for the case referred to. On the other hand, from the analytical standpoint it appears to be desirable to utilise an expression for ds^2 which is symmetrical in *all* the variables. The author attempts to reconcile these two points of view. J. S. G. T.

1475. Linearity of the Lorentz Transformation. H. Brell. *Akad. Wiss. Wien, Ber.* 139. 2*a*. 7–8. *pp.* 451–458, 1930.—The Lorentz transformation between variables (x, t) and (x', t') is established by considering the most general transformation which leaves the expression $\frac{\partial^2\phi}{\partial x^2} - \frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2}$ (ϕ arbitrary), unchanged in form. It is shown that the Lorentz transformation is the only possible one. G. C. McV.

1476. Unified Field Theory. Parts II and III. T. Y. Thomas. *Nat. Acad. Sci., Proc.* 16. *pp.* 830–835, *Dec.,* 1930 *and* 17. *pp.* 48–57, *Jan.,* 1931.—A number of identities between first and second absolute derivatives of the fundamental h^i_a [see Abstract 1110 (1931)] are given as well as the definition of the divergence of an absolute invariant. The h^i_a are interpreted physically as electromagnetic potentials and the system of field equations now proposed is that the divergence of the

$h^i_{j,k}$ (first absolute derivatives of the h^i_j) should be zero. This has the advantage of basing the field equations on a conservation law. At the same time, the present field equations differ from those given in the first paper of this series only in terms quadratic in the $h^i_{j,k}$. Since these latter gave Maxwell's equations exactly in the local coordinates at a point, it may be said that the present set give Maxwell's equations only in the case when the electromagnetic field is weak, *i.e.*, as first approximations. Part II concludes with a calculation of the number of independent absolute derivatives of order $(r + 1)$ of the h^i_j at a point Q; firstly, when the nature of the space is not restricted by any field equations and, secondly, when the author's set of such equations is imposed. In Part III the author deduces a general existence theorm of the Cauchy-Kowalewski type for the field equations already obtained. The characteristic surfaces of the equations are also determined. G. C. McV.

1477. Redetermination of the Constant of Gravitation. P. R. Heyl. *Bureau of Standards, J. of Research,* 5. *pp.* 1243–1290, *Dec.*, 1930.—A redetermination of the constant of gravitation has been made, using the torsion balance in vacuo. The large masses were steel cylinders weighing about 66 kg, and the small masses spheres of gold, platinum and optical glass. The final result obtained is $6{\cdot}670 \times 10^{-8}$ cm^3 g^{-1} sec.$^{-2}$. While the results obtained appeared to differ slightly with small balls of gold, platinum or glass, it was shown by a special experiment with the form of torsion balance used by Eötvös that this is not to be attributed to difference in material. AUTHOR.

1478. Temperature Equilibrium in a Static Gravitational Field. R. C. Tolman and P. Ehrenfest. *Phys. Rev.* 36. *pp.* 1791–1798, *Dec.* 15, 1930.—In the case of a gravitating mass of perfect fluid which has come to thermodynamic equilibrium, it has previously been shown that the proper temperature T_0 as measured by a local observer would depend in a definite manner on the gravitational potential at the point where the measurement is made. In the present article the conditions of thermal equilibrium are investigated in the case of a general static gravitational field which would correspond to a system containing solid as well as fluid parts. Writing the line element for the general static field in the form

$$ds^2 = g_{ij}dx_idx_j + g_{44}dt^2 \qquad i, j = 1, 2, 3,$$

where the g_{ij} and g_{44} are independent of the time t, it is shown that the dependence of proper temperature on position at thermal equilibrium is such as to make the quantity $T_0\sqrt{g_{44}}$ a constant throughout the system. [See also Abstract 3055 (1930).] AUTHORS.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

1479. Adiabatism in Balloons. M. Panetti. *Accad. Sci. Torino, Atti,* 65. 1–3*a*. *pp*. 41–47, 1929–1930.—Discusses the conditions of adiabatism in balloons, and develops a new set of adiabatic equations to meet these conditions. These enable the ascensional force to be calculated which will confer stability on the balloon in its movement. A. D.

1480. Motion of Masses of Air. M. Lombardini. *Accad. Lincei, Atti.* 12. *pp*. 114–119, *Aug*., 1930.—Jaumotte's formula for the isobaric-isosteric solenoids contained in any closed curve is worked out in a more concise way by means of the vector calculus. E. E. F. d'A.

1481. Lunar Influence on the Atmospheric Pressure in the Far East. *Faculty of Sci. Tokyo, J.*2. *pp*. 73–131, *Dec*. 10, 1930.—Data have been extracted for 36 stations in and near Japan for a 19-year cycle ending in 1924, and values of the day-by-day average pressure obtained. The method of averaging is fully explained and the errors arising in the use of the method are discussed. The three lunar monthly pressure variations (synodic, nodic and anomalistic) are given in tables and figures for each station. The variation in pressure in each cycle is complicated, several maxima and minima being present and harmonic analysis is used to get more comprehensive results. It was found that the amplitudes increase north-eastwards across the Japanese Islands and the curves are simpler in lower latitudes. Maps have been drawn at each of six phases of the three cycles to show the distribution of atmospheric pressure and its variation with lunar motion. It is concluded that the moon exerts an influence on the pressure distribution, small in amplitude but steady in nature while certain meteorological phenomena with 27- to 28-day periods are probably under lunar influence. Reference is also made to possible reactions of this pressure variation on earthquake frequency and latitude variation in the Far East. R. S. R.

1482. Diffusion Regarded as a Compensation for Smoothing. L. F. Richardson and J. A. Gaunt. *Roy. Meteorolog. Soc., Mem.* 3. *pp*. 171–175, *Dec*., 1930.—Reference is made to former work on atmospheric diffusion [see Abstract 1764 (1926)] which was shown not to follow Fick's law. Motions were here divided into (1) those treated in detail, and (2) those smoothed away by some process of averaging. Five different types of smoothing and the type of law appropriate for each are considered. These include the behaviour of moments for means of clusters, a differential equation for the long-time mean and a differential equation for means over chequers. Some observations are recorded on pairs of foam flecks on a river and these behave like clusters in the atmosphere. R. S. R

1483. Photographic Photometry of Twilight. F. Schembor. *Gerlands Beitr. z. Geophys*. 29. 1. *pp*. 69–94, 1931.—A full summary is given of the literature dealing with twilight and the nocturnal sky. Observations are lacking for the end of astronomical twilight. In continuation of former observations with the potassium cell [see Abstract 751 (1931)] the results obtained by a photographic method in 1500 tests on 17 days are tabulated. The curves of blackness are measured with a Hartmann microphoto-

meter and are the same as for the potassium cell. The curve is given in stellar magnitudes by $\log m = 306\cdot50\,(1 + \sin^2 z) - 604\cdot00$, where $m = (\log J - 1\cdot700)/0\cdot4$, J being the intensity of twilight and z the solar zenithal distance. The curve is of the 2nd order for measurements with heights of sun above $-4°$. With the small aperture of the camera the measurements can be taken only to $-9°$. A new aperture is to be used to obtain several measurements at the same time in any azimuth.
R. S. R.

1484. Photometric Study of the Penetration of Solar Radiation into the Interior of Pyrenean Glaciers. J. Devaux. *Comptes Rendus*, 191. *pp.* 1358–1360, *Dec.* 22, 1930.—Photometric measurements were made at different depths in the ice of the penetration of solar radiation. It was found that the absorption is a little greater for red than for green radiation, but the selectivity in the visible spectrum is not good. The author explains the results by assuming that the ice absorbs the visible radiation very little, but the absorption quickly increases as the infra-red is reached and most of this does not get beyond the surface layer. In the visible region the absorption is exponential and at the depths tested the total thermal flux may equally have an exponential decrease. R. S. R.

1485. Transfer of Heat by Radiation and Turbulence in the Lower Atmosphere. D. Brunt. *Roy. Soc., Proc.* 130. *pp.* 98–104, *Dec.* 2, 1930.—This paper continues a previous investigation [see Abstract 2977 (1929)] and deals with the limits to the lapse rate which is physically capable of formation in the atmosphere immediately above the ground. The combined effects of radiation and turbulence are first examined with consideration of Taylor's results on the upward transfer of changes of surface temperature, from which it is concluded that the effects of radiation alone are only of importance in the layer in immediate contact with the surface of the earth, and the large-scale variations of temperature with height cannot be explained as purely radiational effects. From a discussion of the formation of nocturnal inversions it is concluded that their observed growth agrees much more closely with the theoretical result with radiation acting alone than the growth of large lapse-rates during the daytime.
H. H. Ho.

1486. Compensatory Potential Function in a Geoid Ellipsoid of Rotation. F. Vercelli. *Accad. Sci. Torino, Atti*, 65. 1–3*a*, *pp.* 48–53, 1929–1930.—In his new gravitational theory Somigliana shows that the gravitational field external to a geoid of any form may be considered as generated by (1) the attraction of the whole geoid mass, supposed uniformly distributed in the interior; (2) the centrifugal force; and (3) by the Newtonian action of a compensating superficial mass, distributed in excess and defect so as to amount on the whole to zero. The author investigates the potential function and the density of this compensating mass, and compares his results with the isostatic distribution of rocks in the crust of the earth. His results are analogous to those of Somigliana for the sphere, and are in harmony with modern views as to the constitution of the lithosphere.
A. D.

1487. Gravity in a Geoid Approximately Spherical. G. Casara. *Accad. Sci. Torino, Atti*, 65. 4–6*a*, *pp.* 69–72, 1929–1930.—In an ellipsoidal geoid, differing very slightly from a sphere and rotating with a velocity of the order of the earth's rotation, the force of gravity on its equator is at a maximum at the extremity of the longer, and at a minimum at the extremity of the shorter, of the two equatorial axes. A. D.

1488. Development of Space Potentials by Spherical Functions. F. Hopfner. *Gerlands Beitr. z. Geophys.* 29. 1. *pp.* 22–28, 1931.—Results are given upon the convergence of series for the potential of space in the form $V = \sum_{n=0}^{n=\infty} (Y_n/l^{n+1})$ and extended by investigation of the first and second derivatives. The paper is wholly mathematical. R. S. R.

1489. Determination of Geoid Oscillations from Gravity Measurements. K. Jung. *Gerlands Beitr. z. Geophys.* 29. 1. *pp.* 29–58; *Disc.*, 59–63, 1931.—Isostatic anomalies of gravity cannot be used without correction to calculate the warping of the geoid since movement of masses, joined to isostatic reduction, shifts the potential surfaces. Two methods are developed to avoid this inconvenience: (1) the effect produced by isostatic reduction upon the position of the potential surface is developed in a series of spherical harmonics; (2) Hopfner's method gives the warping of the potential surfaces, including all masses over which gravity has the same distribution as on the real geoid. The correction for (1) is generally 4 to 5 times that for (2). The calculation gives the order of magnitude and the approximate distribution. By this procedure the isostatic anomalies found by Meinesz over the oceans can be decreased or nearly disappear. It is shown that as a consequence of isostatic reduction only about 1/13 to 1/30 of the ellipticity of latitude found by Helmert, Berroth and Heiskanen can be explained. In the *Discussion*, **Hopfner** criticises the procedure employed to obtain the results of geoid undulation and the author replies. R. S. R.

1490. The Earth. J. W. Gregory. *Inst. Mech. Eng., Proc. No.* 4. *pp.* 957–980, 1930.—The paper is the Thomas Hawksley Lecture and gives a brief general account of the earth from a mechanical point of view.
W. A. R.

1491. Heat Due to Deformation of Earth's Crust. T. Terada. *Tokyo Univ. Earthquake Research Inst., Bull.* 8. *pp.* 377–383, *Dec.*, 1930. *In English.*—The heat evolved in faulting is calculated: (*a*) on the assumption that there is a finite thickness of material undergoing shear extending between the boundary planes of the faulted area; and (*b*) that there is a simple slide along a plane with definite coefficient of friction. The results on reasonable assumptions as to friction, extent of faulting, etc., show that enough heat would be evolved to explain, at least to some extent, the heat of hot springs occurring along fault lines. The idea is extended to that of heat evolution due to friction in a layer of sima at the base of a drifting continent—causing diminution in viscosity, and so facilitating the movement. C. A. S.

1492. Analytical Treatment of Horizontal Deformation of the Earth's Crust. C. Tsuboi. *Tokyo Univ. Earthquake Research Inst., Bull.* 8. *pp.* 384–392, *Dec.*, 1930. *In English.*—The horizontal movement of the earth at the Tokyo Astronomical Observatory that accompanied the great Kwantô earthquake of 1923 has been deduced from the results of the re-survey made after that event, and compared with the change in dimensions of the standard rhombus base thereat, which is re-measured every year. The two results correspond sufficiently well. The latter also shows a slow expansion for several years before the earthquake, followed by a large expansion when it occurred. Simultaneously the coast at the neighbouring point of Aburatubo rose some 1·5 m. C. A. S.

1493. Tidal Oscillations in an Elliptic Basin of Variable Depth. G. R. Goldsbrough. *Roy. Soc., Proc.* 130. *pp.* 157–167, *Dec.* 2, 1930.—Lamb has shown that, with a circular basin, having a certain variable depth, the solution of the problem of "long" waves can be expressed in terms of simple algebraic polynomials, and the free periods of oscillation expressed by an extremely simple formula. The author shows that in an elliptic basin, having a paraboloidal law of depth such that, when the eccentricity vanishes, the basin has the same form as that discussed by Lamb, the problem is again soluble in terms of polynomials, and the free periods of any type of motion can be found with ease. H. N. A.

1494. Relation between Tidal Phases and Earthquakes. S. Yamaguti. *Tokyo Univ. Earthquake Research Inst., Bull.* 8. *pp.* 393–408, *Dec.*, 1930.—*In English.* For the numerous groups of after-shocks following four large Japanese earthquakes whose epicentres were known, the times of maximum frequency relative to high and low tide over adjacent seas were extracted. A feature common to all is a maximum frequency of the after-shocks at, or a little before, low water. A secondary maximum occurs before high water for the Kwantô earthquake, but a little after for the Tango, Tazima and Ômati earthquakes. Semidiurnal waves are also shown and are probably related to the diurnal atmospheric pressure changes. R. S. R.

1495. Propagation of Love Waves. S. Higuchi. *Tohoku Univ., Sci. Reports,* 19. 6. *pp.* 793–800, *Dec.*, 1930.—Investigates the problem of the propagation of a Love wave along some complex superficial layers of the earth. Using rather simple calculations, the conditions of the existence of the wave and of no reflected wave in the regions of the incident wave, etc., are derived. AUTHOR.

1496. Observations of the PL Wave. H. Landsberg. *Gerlands Beitr. z. Geophys.* 29. 1. *pp.* 64–68, 1931.—Somville found for earthquakes in central Italy [see Abstract 71 (1931)] a PL wave and observations of it made at the Taunus Observatory are given. The PL wave is found also for other epicentres in the Mediterranean (Messina, Thessaly and Asia Minor) and it appears also to occur with an Iceland earthquake. The time curve given by Somville is completed and extended to a distance of 2500 km. R. S. R.

1497. Detection of Rock-Salt by Electrical Surveying. T. Alty and S. Alty. *Canad. J. of Research,* 3. *pp.* 521–525, *Dec.*, 1930.—Experiments on the detection of rock-salt deposits by electrical methods are described. It is shown that these methods give definite indications of the depth of the deposit when the latter is as much as 600 ft. below the surface. The interpretation of results obtained by the "single electrode probe" method is discussed. AUTHORS.

1498. Insolation Measurements at Geneva Observatory. R. Gautier. *Arch. des Sciences,* 12. *pp.* 380–386, *Nov.–Dec.*, 1930.—A heliograph constructed on the model of Campbell and Stokes's "Sunshine Recorder" was installed in 1896 and continued in operation without interruption until the end of 1928. A second more powerful, and therefore more sensitive, instrument of the same kind was installed in February 1909 and is still working. The two instruments therefore coincided throughout a period of 20 years. The author describes their differences and gives a table of the hours of insolation for each throughout their installations. The differences are most marked when the atmosphere is disturbed, especially by dust storms; in transparent atmosphere there is small difference. For example, there was a great increase in the registration of the hours of sunshine by the second instrument in the years 1912 and 1913 (the differences were 357 and 340 hours) because of the eruption in June 1912 of the Alaska volcano. A. S. D. M.

1499. Improvement of Meridian Observations. E. Esclangon. *Bull. Astronomique,* 6. 6. *pp.* 229–260, 1930.—The accuracy of meridian observations has not greatly improved during the last fifty years, except in one point: observation by eye and ear has been replaced by the automatic and mechanical method now in use, so that the time of passage of a star in the focal plane of a large telescope is recorded within 1/100th of a second of the correct time. But there remain many possible causes of error, due to instrumental imperfections, temperature changes, and irregular variations in the atmosphere. Errors due to this last cause, and especially errors in R.A., are discussed, and detailed instructions are given for installing an instrument and making observations in such a way that real progress may be achieved towards perfecting the results obtained. M. A. E.

1500. Photometric Study of the Solar Corona for Radiations in the Red and Near Infra-Red. A. Lallemand. *Comptes Rendus,* 191. *pp.* 1289–1291, *Dec.* 22, 1930.—The photographs studied were obtained during the total eclipse of May 9, 1929, and were taken through a plate of dark red Jena glass, so that no effect was produced by waves less than 6550 Å., or greater than 7300 Å. in length; there was a sharp maximum of sensitiveness at about 6720 Å. With a second camera, using a different screen, the maximum was at 8300 Å., and some effect was produced from 7350 Å. to 8600 Å. Studying the jets of the corona it was found that the logarithm of the brilliance of an element of the corona diminishes in proportion to its distance from the sun's centre, $\log B = \alpha\rho + \log B_0$. For the same wave-length α is constant, and independent of the region examined. It seems probable that for $\rho = 1\cdot25$ solar radii the colour temperature of the corona relative to radiations 6720 Å. and 8300 Å. is the same as that of the standard lamp employed in the measurements, or 1800° K. The axis of minimum brilliance is inclined about 6° to the axis of the sun. This is the same angle that the magnetic axis makes with the axis of rotation. H. N. A.

1501. Empirical Law Discovered in the Solar System Tested by the New Planet. M. Pierucci. *N. Cimento,* 7. *pp.* 367–373, *Dec.,* 1930. —If the law found some years ago by the author for the relative distances of planets from the sun is compared with the laws suggested by Bode, Gaussin, Belot and Armellini, it appears that the distance of Pluto agrees badly with all these, but excellently with the author's law. According to this, the distances of planets from the sun, and of satellites from their respective primaries, increase as the integral numbers, approximately and with a few gaps. Moreover, the gaps are such that the relative distances bear a very simple proportion to one another, the only factors being 2, 3 and 5, and this is a rule that applied also to the relations found between what was called the " total energy " of the planets, *i.e.*, the mass : semi-major-axis [see Abstract 259 (1926)]. This latter relation cannot yet be tested by applying it to Pluto, since its mass is not yet accurately known. M. A. E.

1502. Variations of Aberration Constant. P. Salet. *Bull. Astronomique*, 6. 6. *pp.* 261–262, 1930.—The author discusses Becker's finding that the aberration constant varies with the spectral type, a result that cannot be explained by a physiological effect in colour-index, nor by the changes found through the spectroscopic method. He suggests a curbing effect through stellar attraction or some other cause; this might be made sensible only through the great distance of stars in spiral nebulæ. He suggests two methods of investigation [see Abstract 3526 (1929)], but the more delicate method when applied to the β Aurigæ and U Herculis gives feeble, not large, results. He urges the measurement of numerous double stars which are in rapid revolution, and the repetition of Becker's work, as well as the correlation of the constant of aberration not only with spectral type, but with giant and dwarf stars. A. S. D. M.

1503. Interference Methods and Stellar Parallax. E. H. Synge. *Phil. Mag.* 10. *pp.* 873–885, *Nov.*, 1930.—Suggests a method for obtaining interference between two beams from a star, which differs from Michelson's, and seems to possess great advantages over it. The method does not essentially depend upon diffraction at all, and interference between two beams can be obtained independently of diffraction by means of a half-silvered plate, the two beams being completely superposed on one another, as in Michelson's ordinary interferometer for measuring wave-lengths. It is proposed to use this method in connection with the form of stellar interferometer, with a long base line, recently proposed by the author [see Abstract 436 (1931)]; and details are given of how chromatic compensation can be obtained for the apparatus by means of an arrangement of crossed wedges. It should be possible with this apparatus to measure stellar diameters. A method is also worked out, using two pairs of siderostats, by means of which it should be possible to measure the parallax of stars in suitable cases, with an accuracy approaching one-millionth of a second of arc. A similar accuracy should be obtainable for the angular diameters, and the actual diameters could then be calculated. H. N. A.

1504. Apsidal Motion in Y Cygni and Other Stars. H. N. Russell and R. S. Dugan. *Roy. Astron. Soc., M.N.* 91. *pp.* 212–215, *Dec.*, 1930.—Eclipsing binaries are often subject to variations in their periods, but Y Cygni is one of the few cases in which the variation can be explained without any doubt as due to motion of the periastron. The line of apsides revolves in 46·8 years, which is equal to 5700 periods of the close pair. The question is discussed whether this revolution is caused by the ellipticity of the stars, or the presence of a third body in the system. It appears that a third body, even of considerable mass, must have a short period in order to produce as great an apsidal motion as a very small ellipticity of the principal stars. Intensive spectroscopic observation during one summer might go far towards solving this problem. M. A. E.

1505. Relation between Sections at Extreme Ends of Stellar Spectrograms. P. Rossier. *Arch. des Sciences*, 12. *pp.* 369–379, *Nov.–Dec.*, 1930.—If a given line is taken as the origin from which the distances *r* and *v* are measured from the red and violet ends respectively, there should exist a relation between these depending especially upon the stellar magnitude, the length of exposure, the make of plate, the instrument and atmosphere. Three functions enter: (*a*) the dispersion of the system, $\lambda = \phi(l)$; (*b*) the distribution of energy in the stellar spectrum, $Ce(\lambda)$, where C depends on the star's magnitude; (*c*) the sensitiveness of the plate $\sigma(\lambda)$; a threshold value *s* defines the extreme ends of the spectrogram for darkening on the plate. The relation $Rv - Vr = A$ is found for stars of the same spectral type; for different spectral types, $R(T)r - V(T)v = r_0R(T) - v_0V(T)$, where the temperature T depends on $e(\lambda)$. The author gives a numerical verification from measures of 200 plates taken in 1928 by the Schaer-Boulenger objective-prism of the Geneva Observatory, and in an Appendix, the curve of dispersion for this instrument made by Mlle. Blaser, and a table of the numerical formula, $1 \cdot 8r - v = 7 \cdot 52$. A. S. D. M.

1506. Suggested Method for Applying Slitless Spectrographs to Doppler Shift Measurement. N. Deisch. *J.O.S.A.* 20. *pp.* 685–692, *Dec.*, 1930.—An objective prism type of stellar spectrograph is adapted for work in either of two operative settings by reversing the prism and shifting the telescope through an angle 2θ (θ is deviation at mean wave-length of the projected spectrum), on its declination axis; the star spectra retain the same positional relation before and after reversal except that the long-wave and short-wave terminators are in inverse relation. If D and D′ separate the positions λ and λ' of a line of given wave-length, displaced by Doppler shift to λ_1 and λ', which are distant *d* and *d′* from the original positions, then D′ differs from D by $d + d' = 2d$, thus furnishing the basis of a method for measuring the Doppler displacement in stellar spectrograms by an objective prism instrument. The author describes several variants of the instrument with their advantages and limitations, and concludes that it is possible to modify the design so that the collimator errors would be reduced to a very low order. A. S. D. M.

1507. Spectrum of H.D. 20336 in Camelopardalis throughout a Complete Cycle (1925–1930). W. J. S. Lockyer. *Roy. Astron. Soc., M.N.* 91. *pp.* 215–226, *Dec.*, 1930.—Further observations have been made of this bright hydrogen-line star, in order to decide between the two periods previously found by Curtiss and the writer respectively. Both were clearly much too short, as Curtiss also independently discovered. The new value obtained at Sidmouth is about 4·3 years. The method was to determine by eye estimates the varying relative intensities of the two bright components in each of the hydrogen lines H_β and H_γ, and these estimates were checked by wedge micrometer measurements. The periodic curve is not a sine curve, and it does not agree well with radial velocity values found by other observers, probably because the complex and nebulous nature of the spectrum makes such values very uncertain. No line other than the bright hydrogen lines appears to vary. Espin's own account of his discovery of bright $H\beta$ in this star is quoted. M. A. E.

1508. Colour and Spectral Type Relations in Different Galactic Latitudes. E. A. Kreiken. *Roy. Astron. Soc., M.N.* 91. *pp.* 242–250, *Dec.*, 1930.—An increase in mean colour with decreasing galactic latitude may depend on three factors. In lower galactic regions: (*a*) temperatures of the stars may be lower, or (*b*) their colours more affected by selective absorption in space, or (*c*) the mean absolute magnitudes of stars apparently brighter than a given limit may decrease with decreasing latitude. It is accepted that, within each spectral type, there is a systematic dependence of colour on absolute magnitude. The author uses Tables I, II and III of Öpik's Catalogue, grouping the stars according to spectral type, absolute magnitudes, galactic longitude and in three galactic latitude zones of 0°—10°, 10°—20°, and 20°—90° (north and south), since Trumpler concludes that within 8° of the galactic equator the stars are affected both by total and by selective absorption. He describes his methods of investigation, and finds that: (1) the mean relation of colour to spectral type does depend systematically on galactic latitude; (2) colour excesses in the galactic regions are almost entirely due to the effect of absolute magnitude; and (3) after applying corrections for absolute magnitude there remains a small colour excess in the low latitudes which varies systematically with spectral type but as these are very small, no general conclusions as to selective absorption in space can be drawn from them. A. S. D. M.

1509. Stellar Axial Rotation. E. A. Kreiken. *Roy. Astron. Soc., M.N.* 91. *pp.* 251–256, *Dec.*, 1930.—A table is given of 59 stars for which Elvey has given the line of sight component of their axial rotations [see Abstract 3694 (1930)] and Hertzsprung their hypothetical semi-diameters; from these and from their parallaxes the author gives the values which the semi-diameters would have if the stars were placed at a distance corresponding to a parallax of 0″·1, and the reduced velocities of rotation corresponding to a reduced semi-diameter, 10. It is found that the angular velocities systematically depend on the values of the reduced semi-diameters. A table and diagram are given of the relation between the logarithm of the mean axial rotation periods and the diameters, and are also expressed by the equation $\log P = 1\cdot 49 \log D - 1\cdot 25$. The periods of axial rotation as derived from the formula and the observed periods of orbital revolution are roughly proportional in the case of spectroscopic binaries and the eclipsing variables, but for Cepheids the computed period of axial rotation is considerably larger than the period of light-rotation.
A. S. D. M.

1510. Investigations of Photographic Light-Curves of Cepheid Variables. Part VI. L. V. Robinson. *Harvard Coll. Obs., Bull. No.* 880. *pp.* 16–20, *Dec.* 1, 1930.—The Hertzsprung relation between period and light-curve suggests that for a given period we may assume the existence of a certain standard light-curve, with which those of all Cepheids with corresponding periods may be compared. Including new data, among which are those of some southern Cepheids, an attempt has been made to reduce the relation between period and $M - m/P$ to a more exact form, and to correlate the deviations from standard light-curve with other characteristics. Only Cepheids with periods between $10^d\cdot 5$ and 30^d, which Hertzsprung found to constitute a distinct class, have been used in this investigation. The supposition is confirmed that with these stars abnormal light-curves are associated with abnormal median spectra, and that these abnormalities are both related with either a longer or a shorter period than the real one. It is not, however, easy to explain why the above correlation should exist. [See also Abstract 3686 (1930).] M. A. E.

LIGHT.

1511. Pigment Primaries and Mixtures. F. F. Rupert. *J.O.S.A.* 20. *pp.* 661–684, *Dec.*, 1930.—The author makes a spectrophotometric examination of single pigments, especially those most used in water-colour work, and also mixtures. He shows that the results of the mixing of paints may be predicted roughly by the determination of the spectrophotometric curves of the constituents. It is possible to predict the general course of the curve of the mixture, but an accurate prediction cannot be made with data and methods now available. He shows that the smallest number of practical primaries must be three, and that they must be blue, yellow and violet red. W. C. S. P.

1512. Hecht's Theory of Vision. D. B. Judd. *J.O.S.A.* 20. *pp.* 647–660, *Dec.*, 1930.—A comparison is presented of the mixture relations embodied in Hecht's tentative theoretical curves [see Abstract 3379 (1930)] with those embodied in the O.S.A. "excitation" curves. It is shown that the two sets differ quite markedly. Since Hecht's method of comparison led him to believe that these two sets of curves embodied essentially identical mixture relations, it is concluded that the method of comparison is inadequate. E. E. F. d'A.

1513. Refractive Indices of Hydrogen, Oxygen, Argon and Nitrogen. J. Tausz and H. Görlacher. *Zeits. f. techn. Physik*, 12. 1. *pp.* 19–24, 1931.—The refractive indices of air, hydrogen, oxygen, argon and nitrogen are measured interferometrically for various wave-lengths in the visible region. Special precautions are taken in the purification of the gases. The results are tabulated and compared with those of all previous observers. C. B. A.

1514. Specific Dispersion of Cyclic Hydrocarbons. M. Godchot and G. Cauquil. *Comptes Rendus*, 191. *pp.* 1326–1328, *Dec.* 22, 1930.—The specific dispersions $\Delta n/d$, where Δn is the difference $n - n'$ of the refractive indices of a hydrocarbon for two wave-lengths λ and λ', are determined for a number of saturated cyclic hydrocarbons (cyclopentane, cyclohexane, etc.) and the analogous unsaturated cyclic bodies. Δn increases regularly with the molecular weight, and is greater in the unsaturated than in the corresponding saturated hydrocarbon. The specific dispersion is approximately constant at 124×10^{-4} for the saturated series, and at 151×10^{-4} for the unsaturated, and is not markedly affected by the nature of the cycle. These observations and the additive character of the specific dispersion can be applied to the quantitative estimation of the constituents of an essence. A. J. M.

1515. Scattering of Light at the Critical Point. G. Placzek. *Phys. Zeits.* 31. *pp.* 1052–1056, *Dec.* 1, 1930.—It is shown that in the immediate neighbourhood of the critical point, the dimensions of the scattering element become important, and when this is taken into account Rocard's objections to the Ornstein-Zernike theory [see Abstract 457 (1929)] cease to hold. Expressions for the lateral scattering and for extinction in the modified theory, are worked out. W. S. S.

1516. Magnetic Rotatory Polarisation of Organic Substances Liquefied by Fusion. C. Salceanu. *Comptes Rendus*, 191. *pp.* 1316–1318, *Dec.* 22, 1930.—Describes measurements of the magnetic rotatory power of naphthalene and β-methylnaphthalene, for temperatures up to about 180° C., using three mercury lines. The curves representing the thermal variation of the rotations show a weak curvature convex to the temperature axis. The rotatory magnetic dispersions are calculated and compared with the dispersions of the magnetic double refraction previously measured. The agreement appears to be satisfactory. W. S. S.

1517. Magnetic Rotatory Power of Gaseous Hydrocarbons. R. de Mallemann and P. Gabiano. *Comptes Rendus*, 191. *pp.* 1319–1320, *Dec.* 22, 1930.—Measurements of the magnetic rotatory power of the first six members of the methane series, in the gaseous state, and of butane, pentane and hexane in the liquid state, are reported. The ratio of the specific rotations in the gaseous and liquid states for the three last mentioned hydrocarbons equals about 0·86, in good agreement with the theoretical ratio calculated from the indices. The principal difficulty encountered was the purification of the hydrocarbons. Where possible this was done by distilling from the liquefied hydrocarbon. W. S. S.

1518. Use of Kerr Cells for the Measurement of Time Intervals and the Production of Flashes of Light. J. W. Beams. *Rev. Sci. Instruments*, 1. *pp.* 780–793, *Dec.*, 1930.—The Kerr cell is well suited to the measurement of very small intervals of time and the production of short flashes of light. The paper reviews the present knowledge on the subject, and describes the technique developed by the author for investigation of the order of appearance of spectrum lines in sparks and condensed discharges. An arrangement is also described to enable an observer to view phenomena for a very short time at a definite stage without masking effects of the preceding and succeeding parts, or to produce flashes of light of short duration. A full Bibliography is appended. S. G. B.

1519. Objective Production of the Haidinger Polarisation Pencils of Rays. E. Gehrcke. *Phys. Zeits.* 31. *p.* 957; *Disc.*, 957–958, *Nov.* 1, 1930. *Paper read before the Deut. Physikertag., Königsberg, Sept.*, 1930.—Describes briefly a method, using a non-depolarising projection screen, whereby it is possible to obtain the Haidinger pencils of rays objectively and not subjectively. Approximately 30 % of the world's population are not able to see these yellow and violet pencils of rays. In the *Discussion*, **H. Dember** pointed out that many physiological causes, such as the effects of alcohol and tobacco, can affect the ability of the eye to perceive the phenomena. R. C. F.

1520. Representation of the Astigmatic Pencil and Mannheim's Auxiliary Line. M. Dufour. *Comptes Rendus*, 191. *pp.* 1311–1314, *Dec.* 22, 1930.—A note on geometrical optics, bearing on the construction of caustics. W. S. S.

1521. Linear Projector. C. Dévé. *Comptes Rendus*, 191. *pp.* 1444–1447, *Dec.* 29, 1930.—Two semicircular glass slips, *e.g.*, one blue and the other red, are placed so that the two straight-line edges are parallel and form a slit as for a spectroscope. A distant image of the slit can be obtained which may be aligned in any desired direction. The image will be coloured blue or red depending on the displacement to one side or the other of the optical axis. The arrangement can be used to get (1) an underground direction parallel to that on the ground, (2) accurate vertical directions, or (3) accurate ship directions. R. S. R.

1522. Photometric Efficiency of Optical Instruments. V. Ronchi. *N. Cimento*, 7. *pp.* 374–379, *Dec.*, 1930.—The luminosity of telescopes depends not only on the various reflections and absorptions undergone by the light but also on the degree of correction of the lenses. The aggregate effect the author proposes to call the photometric efficiency. It may be measured by observing the same source through two telescopes, and finding how much it has to be reduced before extinction occurs. E. E. F. d'A.

1523. Theorems Relating to the Brightness of Secondary Sources. J. Dourgnon and P. Waguet. *Comptes Rendus*, 191. *pp.* 1314–1316, *Dec.* 22, 1930.—In an optical system of mirrors and lenses the brightness at any point never exceeds the maximum total brightness of the source. The same theorem is shown to hold in certain cases when the reflection and transmission instead of being specular obey Lambert's law. It is probably true too for all other cases of diffusion. The total effective brightness of the source cannot be exceeded by that of any secondary source, but it is possible to augment the primary brightness of the source by redirecting some of the emitted light back on to the source. An example of this kind, consisting of two concentric spheres emitting and reflecting in accordance with Lambert's law, is discussed in detail. **Errata,** *ibid.* 192. p. 68, Jan. 5, 1931. W. S. S.

1524. Integrating Photometer for X-Ray Crystal Analysis. B. W. Robinson. *Roy. Soc., Proc.* 130. *pp.* 120–133, *Dec.* 2, 1930.—Astbury described [see Abstract 2725 (1929)] a simple X-ray photometer based upon the method which involves the reproduction of the photograph by the bichromated gelatin process as a thin membrane whose thickness diminishes with increasing opacity of the original. This membrane is then used as an obstacle to a beam of α-particles from a uniform polonium source, and the ionisation produced by the α-particle penetrating the tissue is found to measure the energy which formed the spot on the original record. Astbury has shown how such a photometer may be used for intensity measurements, and the present paper gives an account of an improved instrument now in use at the Davy Faraday Laboratory of the Royal Institution, London. The account deals successively with (*a*) discussion and design of the instrument, (*b*) technique of intensity measurement by this method, and (*c*) review of results obtainable. The results obtained, whilst showing the weaknesses of the α-ray photometer, would at least seem to show that the photometer has an undoubted position in the technique of X-ray intensity measurement. For the complete survey of the intensities of reflection from a crystal, particularly when the crystal is small or easily volatile and a photographic method must be used, the α-ray photometer is the best and perhaps the only instrument that can be used. Full details are given under each heading. S. G. B.

1525. Determination of Ur-Silver in Photographic Gelatins. H. H. Schmidt and F. Pretschner. *Zeits. f. wiss. Phot.* 28. *pp.* 293–297, *Dec.*, 1930.—This paper, which criticises Weigert and Luhr's results [see Abstract 2510 (1930)], is mainly an examination of the present authors' previous results. A value of atomic silver such as that given by Weigert and Luhr cannot be obtained after fixing in thiosulphate or sodium sulphite with either washed or normal silver chloride emulsions, so that the previous differentiation made is unnecessary. Any atomic silver value obtained is within the limits of experimental error. Further, no influence of the time of ripening on the silver mixture obtainable after fixation can be established. The method used by Weigert and Luhr appears to be one in which a number of uncontrollable processes enter, and if the experiments were repeated on the electrometric basis it is unlikely that they would obtain identical results. Finally, from considerations of the present authors' latest results [see the two following Abstracts], it is shown that the silver value obtained is almost completely due to silver oxide which forms, with gelatin, a complex salt, which is difficult to dissolve. The best fixing medium yet known is sodium sulphite. R. C. F.

1526. Silver Value and Fixing Process. H. H. Schmidt and F. Pretschner. *Zeits. f. wiss. Phot.* 28. *pp.* 297–302, *Dec.*, 1930.—It has already been shown that with sodium sulphite as the fixing medium the silver value for silver chloride emulsions can be divided into two parts [see Abstract 1430 (1930)]. This is further examined, considering Weigert and Luhr's results, and a comparison is made between thiosulphate and sodium sulphite. Figures are given which clearly indicate the small solubility of silver in the sodium sulphite even after 18 hours' fixing, compared with that dissolved by thiosulphate after 50 min. With synthetic emulsions the silver salt is quantitatively dissolved by thiosulphate and sodium sulphite, the latter indicating that the silver value obtained is not due to metallic silver. R. C. F.

1527. Formation and Chemical Nature of the Silver Value. H. H. Schmidt and F. Pretschner. *Zeits. f. wiss. Phot.* 28. *pp.* 302–311, *Dec.*, 1930.—The silver value has its origin in hydrolysis due to differing diffusion velocities of the chlorine and silver ions in the gelatin, and further consists of silver oxide. This stains the gelatin and forms with it a silver oxide-gelatin complex salt which is difficult to dissolve. The mass of silver oxide obtained in the gelatin after washing is dependent upon the ratio of the solubilities of the silver halide and of the silver oxide-gelatin complex, increasing with increasing solubility of the silver halide when the solubility of the complex remains constant. The mass of the silver oxide also reaches an end value very quickly. R. C. F.

1528. New Photochemical Effect with Celloidin Paper. H. Mewes. *Zeits. f. wiss. Phot.* 28. *pp.* 311–324, *Dec.*, 1930.—Describes a new effect which is to be observed with silver halides and particularly with the silver chloride copying emulsions known as "celloidin" paper. The effect is termed the L-effect and is obtained when materials for examination are placed in a dielectric inside an ebonite or colourless metal-free papier-mâché box, and the celloidin paper exposed for a period of 60–90 sec. The method of development is given, and after development a mixed photochloride surface is obtained which is heterogeneously coloured. It is an essential characteristic that there is a close relationship between the colourings and the object surface. Using circular materials, a halo type of image is obtained on top of the true circular image, the halo consisting of concentric rings. The celloidin in the L-chamber when exposed over the non-illuminated boundary surface of a known substance, shows a representation of this surface which is for all distances from the object surface an enlarged view. Twenty-nine elements ranging from carbon to uranium have been found to produce this effect. The picture is decided by the pencil of rays of the maximum energy, the action of other beams falling on the same place being suppressed. It is further shown that the colour of the central picture is always much nearer the violet end of the spectrum than are the others; the further they are out the nearer do they approach to the red end. This can be explained by the total energy of the pencil of rays, for going outwards from the centre the total energy is found to decrease rapidly from its maximum value. A number of pencils are emitted from each surface showing L rays, and these remain as separate units. Finally, the propagation of the L rays does not follow a straight line law but is often curvilinear and certainly parabolic. R. C. F.

1529. Point-Concentration or Centripetal Theory of Light Action. A. Steigmann. *Kolloid Zeits.* 53. *pp.* 318–322, *Dec.*, 1930.—Recent publications on this subject are discussed. T. H. P.

1530. Thermoluminescence in Glasses which Contain Two Activators. B. E. Cohn and W. D. Harkins. *Am. Chem. Soc., J.* 52, *pp.* 5146–5154, *Dec.*, 1930.—The material chosen as the solid solvent was a zinc borate glass, as previous experiments [see Abstract 2811 (1930)] had shown that a similar material could be reproduced exactly and that activators could be uniformly dispersed through this medium. The thermoluminescence of such a glass which contains a small amount of manganese is increased by small amounts of cerium but decreased by larger amounts; the effects of one activator on the other are not additive. The emission spectrum of zinc borate glass which contains Mn has been found to be a band. Single-ended absorption bands have been found in the ultra-violet spectra with zinc borate glasses which contain Mn, Ce, or Th as the solute. Intensity measurements of the thermoluminescence were used to indicate that it is probably from near the edge of these bands that the energy for thermoluminescence is drawn; the relative intensities for two materials in the same solvent changes with a change of the source of excitation. The authors also investigated the absorption spectra of glasses which exhibited thermoluminescence and an anomalous absorption was found for zinc borate glasses which contain manganese. W. C. S. P.

1531. Fluorescence of Quartz under the Influence of Kathode Rays of Low Voltage. H. Peters. *Phys. Rev.* 36. *pp.* 1631–1635, *Dec.* 1, 1930.—Some experiments on the production of a red fluorescence in glass and quartz by kathode rays are described. It was found that the red glow could be produced in highly evacuated tubes and that the presence of oxygen or other gases was not essential. This is contrary to the conclusion of Wood [see Abstract 3220 (1930)]. A spectroscopic study of the fluorescence showed a continuous spectrum with two maxima in the red, one in the green and one in the blue. No trace of any oxygen line was found. The observation that the red fluorescence disappears after about 70 hours of bombardment indicates that the SiO_2 group in the glass goes over into an allotropic modification. AUTHOR.

1532. Fluorescence of Excited Mercury Atoms. Z. Zajac. *Comptes Rendus*, 191. *pp.* 1304–1306, *Dec.* 22, 1930.—The mercury vapour was excited by the simultaneous action of h.f. electrical oscillations, with external electrodes, and a mercury lamp with condensers which concentrated a very intense beam, which filled almost the whole section of the mercury tube. The results obtained led to the following theory of the phenomena produced: the oscillating discharges produce shocks, which carry the Hg atoms to the states 2^3P_{012}, the distribution between these states being non-uniform. They then absorb from the incident light beam certain frequencies corresponding to the passage to the 2^3S_1 state. The return to the normal state is accompanied by the emission of the fluorescence observed. H. N. A.

1533. Quantum Theory of Spectra. L. Bruninghaus. *R.G.E.* 28. *pp.* 933–947, *Dec.* 13, *and pp.* 990–1005, *Dec.* 20, 1930.—This consists of a review of the theory of spectra based on the conception of electronic orbits. Part I deals with the general atom and with hydrogen in detail; Part II with molecular spectra, giving many photographs of bands, and a detailed description of the formulation of the bands of cuprous iodide as an example. The summary is written more from the descriptive than the mathematical point of view. A. C. M.

1534. Spectrum Analysis for the Detection of Foreign Elements in Metals. L. Amy. *Comptes Rendus*, 191. *pp.* 1049–1050, *Dec.* 1, 1930.—The method consists essentially in photographing the spark between the metal electrodes for several successive seconds, and comparing the pictures thus obtained. Certain lines which are present at the beginning disappear after two or three seconds and these lines may be identified with the impurities in the metal. The phenomenon depends on the difference of the volatility of different elements. A technique is deduced and fully described for the detection of such impurities in metals. Lead, zinc, copper, iron and aluminium have been thus examined, and tables of results are appended showing a reinforcement of the rays of magnesium, calcium and carbon by this method. S. G. B.

1535. Investigations in the Infra-Red Region. Part I. Introductory and Experimental. Part II. Absorption Spectrum of Sulphur Dioxide. C. R. Bailey, A. B. D. Cassie and W. R. Angus. *Roy. Soc., Proc.* 130. *pp.* 133–156, *Dec.* 2, 1930.—The apparatus used consisted of a Hilger infra-red spectrometer and Paschen galvanometer. In Part I the installation is described, especially the mounting of the galvanometer, and various considerations respecting accuracy, resolution, etc., are dealt with. Part II records measurements made on sulphur dioxide using prisms of quartz, fluorite, rock-salt and sylvine. Bands were found at $16 \cdot 494\,\mu$, $8 \cdot 680\,\mu$, $7 \cdot 347\,\mu$, $5 \cdot 345\,\mu$, $4 \cdot 338\,\mu$ and $4 \cdot 003\,\mu$. An accuracy of $0 \cdot 003\,\mu$ is claimed. The values are compared with those of Coblentz and those given by the Raman spectrum. The structure of the molecule is also discussed. F. S.

1536. Experimental Allocation of the H_2 Band System to the Singlet and Triplet System. W. Finkelnburg. *Zeits. f. Physik*, 66. 5–6. *pp.* 345–349, 1930.—In investigating the excitation functions of mercury lines Schaffernicht [see Abstract 3429 (1930)] discovered characteristic differences between the singlet and triplet lines. The author calls attention to the fact that Gehrcke and Lau found analogous results in the case of H_2 lines, so that it becomes possible to assign the H_2 band systems to the singlet and triplet systems respectively. The explanation for the narrowly limited excitation function found for the triplet lines is given by some reflections of Beutler and Eisenschimmel on the probability of an electron exchange during excitation by electronic collision. It

appears definitely that the α-, β-, γ-, δ-bands represent the triplet system of H_2, whereas the A-, B-bands and analogous bands represent the singlet system of hydrogen. Observations by the author of the excitation function of the continuous spectrum of hydrogen agree well with this conclusion.
H. L. B.

1537. Excitation Functions of Atomic Hydrogen. L. S. Ornstein and H. Lindeman. *K. Akad. Amsterdam, Proc.* 23. 10. *pp.* 1097–1100, 1930. *In German.*—A method is given whereby it is possible to bombard hydrogen in atomic form with electrons of determined velocity. Moist hydrogen is electrically excited in a Wood's tube, and during this process is pumped away through a side tube with great velocity. In this the excited atoms are struck by electrons from a glowing kathode in a cross tube which have attained a definite velocity through an accelerating grid. A photograph of the spectrum in the cross tube is given. The values obtained for the excitation functions of the $H\alpha$ and $H\beta$ levels are given in a curve. The ratio $H\alpha/H\beta$ is about 5, which is in satisfactory agreement with the theoretical results.
J. J. S.

1538. New Bands in the Secondary Spectrum of Hydrogen. Part III. D. B. Deodhar. *Phil. Mag.* 10. *pp.* 1082–1095, *Dec.*, 1930.—Deals with the group of bands in the violet previously reported [see Abstract 2186 (1930)]. The intensities and wave-lengths are tabulated, with an analysis of the system, showing the various initial and final terms. The moment of inertia of the molecule in the various states is also computed.
J. H. A.

1539. Continuous Spectra of the Hydrogen Atom and Molecule. D. Chalonge and N. T. Zé. *J. de Physique et le Radium*, 1. *pp.* 416–425, *Dec.*, 1930.—The experimental conditions favourable for obtaining the continuous background in the hydrogen spectrum are set out. The continuous spectrum of the molecule covers the whole spectrum from the near infra-red up to the beginning of the Schumann region. The authors have measured its intensity by photometric means, and find that it has a maximum in the neighbourhood of 2350 Å. The continuous spectrum due to the atom can be divided into portions, each associated with a spectral series of the atom—the Balmer series, Paschen series, etc. These also have been measured photometrically, and it is found that the intensity throughout the region associated with a given spectral series is practically constant. The intensity in the region 2900 to 3900 Å. (associated with the Balmer series) is about four times as intense as the part associated with the Paschen series.
J. H. A.

1540. Relationships between the Continuous and the Many-Lined Spectra of Hydrogen. Y. Hukumoto. *Tohoku Univ., Sci. Reports*, 19. 6. *pp.* 773–792, *Dec.*, 1930.—Investigations on the continuous and the many-lined spectra of hydrogen seem to show that there is a certain relationship between the origin of the continuous spectrum and the electronic states of the term systems of the spectrum of the hydrogen molecule. Certain band groups of the many-lined spectrum are often strong when the continuous spectrum is intense. The behaviour of the hydrogen spectrum under different conditions of pressure was observed and the relative intensity was estimated. According to our observation, most of the lines which are enhanced at the higher pressure are classified as the transitions $3^3\Pi \rightarrow 2^3\Sigma$, $4^3\Pi \rightarrow 2^3\Sigma$, etc. According to the recent interpretation of Winans and Stueckelberg [see Abstract 1549 (1929)], this continuous spectrum originates in the transition from any one of the excited triplet levels to the unquantised ground state $1^3\Sigma$ of this system. These experimental facts seem to favour their view, and it is suggested that the explanation of them will contribute to the ultra-violet region of the continuous spectrum. AUTHOR.

1541. Emission Spectra of Benzene Derivatives. J. B. Austin and I. A. Black. *Am. Chem. Soc., J.* 52. *pp.* 4755–4762, *Dec.*, 1930.—In continuation of previous work [see Abstract 2831 (1930)], the spectra of toluene, ethylbenzene, o-, m- and p-xylene have been investigated. They contain a number of bands accompanied by a continuous background. The numerical data agree with those of McVicker, Marsh and Stewart [see Abstract 1382 (1923)]. The spectra have a limited application in qualitative analysis, but are rendered less suitable for quantitative work by the continuous background. F. S.

1542. Modifications Produced in the Fine Structure of a Spectral Line by Molecular Diffusion. M. Vacher. *Comptes Rendus*, 191. *pp.* 1121–1123, *Dec.* 8, 1930.—The author has endeavoured to measure the broadening of the 4358 Å. line, or group, of mercury by diffusion at different angles in benzene, and the shift of the line towards long wavelengths. Details are given of the minute precautions employed in obtaining a photographic record of the modification produced in the interference rings, made use of in the measurements. It was found that the broadening increased with the angle of diffusion. The edge of the line on the short wave-length side is not sensibly altered by diffusion. The centre of gravity of the line is shifted towards the red by the following quantities measured in hundredths of 1 Å. for the angles of diffusion *b* given: 30°,0·10; 90°,0·87; 150°,1·29. It was not possible to decide whether $d\lambda$ varied proportionally to sin $\beta/2$ or to sin $^2\beta/2$. H. N. A.

1543. Fine Structure of a Spectral Line after Molecular Diffusion. J. Cabannes. *Comptes Rendus*, 191. *pp.* 1123–1125, *Dec.* 8, 1930.—Leaves out of account the Raman lines, and analyses only the fundamental line itself, with the unresolvable band round it. Endeavours to examine the experimental results, and the present theoretical ideas. The original line is continued after diffusion by a continuous spectrum, several tens of Ångströms long, which is more intense and more extensive on the side towards the red; and the original line itself is considerably altered. The continuous spectrum is almost completely depolarised; it is more intense the more anisotropic the molecules are, and the intensity is not more than one-tenth of that of the original line. Its origin seems to be similar to that of the rotation lines (P or R branches) observed in diffusion in gases by Rosetti and explained theoretically by Mannebeck. Mentions the effect on the original line, observed by Vacher for benzene [see preceding Abstract]. The theory, which endeavours to explain the effect of diffusion by means of the elastic waves which result in a thermal agitation of the medium, leads to two waves $\lambda \pm d\lambda$. As measured by Vacher in benzene, $d\lambda$ is very different from that calculated by this theory and is not the same on both sides of the original line. H. N. A.

1544. Hyperfine Structure of S and P Terms of Two-Electron Atoms with Special Reference to Li^+. G. Breit and F. W. Doermann. *Phys. Rev.* 36. *pp.* 1732–1751, *Dec.* 15, 1930.—Discusses the theory of the interaction between nuclear magnetic moment and the valency electrons, which results in hyperfine structure. Dirac's wave equation for a single electron is taken as basis assuming a vector potential A corresponding to the magnetic field of the nuclear moment. For the case of two or more valency electrons with which the paper is particularly concerned the perturbation energy for the system is assumed to be the sum of the perturbation energies for the electrons taken singly. The interaction Hamiltonian is applied to the ^{3}S and ^{3}P terms of two-electron atoms for the case of Russell-Saunders' coupling. An exact formula is derived for the resultant hyperfine structure of ^{3}S terms and corrections to the Goudsmit Bacher formulæ for ^{3}P terms are given. It is shown that the Landé interval rule for the former is exact, and that therefore the ratio of intervals can be used to determine nuclear moments. Applying the theory to the Li+ 5485 Å. line, and using Schüler's wave-length data, the nuclear *g* factor is 2·13 assuming the nuclear spin to equal 3/2. Thus the magnetic moment of the Li_7 nucleus is approximately three times the theoretical magnetic moment of a proton. W. S. S.

1545. Large Displacements in the Spectra of Ionised Nitrogen. K. Asagoe. *Tokyo B.D., Sci. Reports,* 1. *pp.* 47–61, *Dec.* 20, 1930.—The spectra of NII and NIII were excited by discharge in nitrogen, both at 7 cm. and at atmospheric pressures, and photographed with glass and quartz spectrographs. All the lines of NII are found to move towards the red and those of NIII towards the violet. The shifts are measured and discussed in relation to the terms concerned. F. S.

1546. Structure of the Spectrum of Singly Ionised Zirconium. C. C. Kiess and Harriet K. Kiess. *Bureau of Standards, J. of Research,* 5. *pp.* 1205–1241, *Dec.,* 1930.—75 % of the lines observed in the spark spectrum of Zr have been classified as combinations between terms of the quartet and doublet systems of Zr II. The terms which have been found are in all cases those required theoretically for an atom with three outer electrons. All the terms, except one, which can possibly arise from configurations of the electrons when they occupy 4*d*, 5*s*, and 5*p* orbits have been found. Of the terms possible when one of the electrons removes to a 5*d* or 6*s* orbit only a few have been found, of which some form Rydberg series with the low terms. In all, 10 pairs of series-forming terms have been detected with either ^{3}F, ^{1}G, or ^{1}D of Zr III as limit. The results given by these different series for the distance between $a^4F_{1\frac{1}{2}}$, the lowest term of Zr II, and a^3F_2, the lowest term of Zr III, are very consistent, the mean value being 113,175 cm.$^{-1}$, corresponding to an ionisation potential of 13·97 volts for the ion Zr+. The irregular doublet law shows a close parallelism between the term structures of the neutral Yt atom and the singly ionised Zr atom. The list of Zr II lines appearing in the sun is extended and includes lines which have not been observed in laboratory sources but may be calculated from permissible combinations. AUTHORS.

1547. Spectrum of Singly Ionised Chlorine (Cl II). K. Murakawa. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 282. *pp.* 41–67, *Dec.* 25, 1930.—The first spark spectrum of chlorine has been obtained by a condensed discharge through a narrow Geissler-tube with tungsten electrodes, one containing a small quantity of sodium chloride. Strong lines have been analysed into term-combinations. The ground term of

Cl II has been fixed, and the ionisation potential of Cl II has been calculated to be 23·115 volts. AUTHOR.

1548. Calculation of the Spectra of Ions. E. Fermi. *Accad. d'Italia, Mem.* 1 (*Fis.*) 2. [10 *pp.*], 1930. *N. Cimento,* 8. *pp.* 7–14, *Jan.,* 1931.—The statistical method introduced by the author for the calculation of the properties of neutral atoms is here extended to the case of ionised atoms, and is applied in particular to the determination of Rydberg's corrections for the *s* terms of the spectra of atoms thrice ionised. The experimental data are remarkably in accord with the theory. A. D.

1549. Molecular Spectra and Structure of the Molecule. H. Deslandres. *Comptes Rendus,* 191. *pp.* 1404–1407, *Dec.* 29, 1930.—The frequency 1062·5 cm.$^{-1}$ and its multiples and submultiples, appears as a constant in both atomic and molecular spectra. It also appears in a two-term formula for absorption spectra. The present paper discusses it in relation to published results of infra-red reflection spectra and of Raman spectra. A table of values is given. **Erratum,** *ibid.* 192. p. 120, Jan. 12, 1931. F. S.

1550. Raman Effect and Polymerisation of Water at Various Temperatures. O. Specchia. *N. Cimento,* 7. *pp.* 388–391, *Dec.,* 1930. —At surrounding temperature the Raman spectrum of water excited by a mercury arc is constituted in the spectral region from 4108 to 5790 Å. of three very intense bands at 4176 Å., 4693 Å. and 5158 Å., and of two other very feeble bands at 4258 Å. and 4480 Å. The bands at 4176 Å. 4693 and Å. are each made up of three components. The modifications that the band at 4176 Å. presented on increase of the temperature were studied, and it was proved that they consist in a diminution of the intensity of the component that corresponds to the less infra-red frequency and in a displacement of the whole band towards the greater wave-lengths. J. J. S.

1551. Raman Effect at the Critical Point. G. Placzek. *K. Akad. Amsterdam, Proc.* 33. 8. *pp.* 832–840, 1930. *In German.*—Intensity measurements at the critical point of a methyl-alcohol hexane mixture show that the intensities of the Raman lines remain unaltered, while the intensity of the continuous Raman spectrum increases. This continuous spectrum behaves in the way which would be expected if it were due to vibrations of molecular groups. A. C. M.

1552. Study of the Raman Effect in Certain Substances with a New Apparatus. B. Venkatesachar and L. Sibaiya. *Indian Journ. Phys.* 5. *pp.* 747–754, *Dec.* 31, 1930.—An apparatus is described for studying the Raman effect in which the exciting arc is produced in the annular space between two coaxial tubes, the inner one of which is of fused silica and the outer of pyrex glass. The substance under examination is placed in the inner quartz tube and is surrounded on all sides by the exciting arc. Strong ultra-violet lines, such as the resonance line of mercury (2536 Å.), may be used as the exciting radiation. The effect of change of temperature on Raman lines is examined by sending a current of air through the inner tube. Calcite and aragonite have been studied with this new apparatus. Halite and fluorite give negative results. Acetylene gas gives Raman lines corresponding to the infra-red absorption bands at 2·45 μ and 7·5 μ; the latter comes up as a double line corresponding to the points of maximum absorption recorded by Levin and

Meyer. The strong absorption band at $13 \cdot 7\ \mu$ gives no corresponding Raman line. The temperature effect on the continuous wings accompanying unmodified lines in the scattered spectrum was studied, and their origin is suggested. AUTHORS.

1553. Filling of a Spectrograph with Light. J. R. Nielsen. *J.O.S.A.* 20. *pp.* 701–718, *Dec.*, 1930.—The light gathered by a spectrograph is considered mathematically, both when a condensing lens is used and when it is not. It is concluded that the focal length of the collimator lens is entirely immaterial in the former case, providing that the condensing lens chosen be the most favourable, while if the focal length be rather long the use of a condensing lens may often be avoided. F. S.

1554. Comparison of Critical Angle of Reflection and Index of Refraction of X-Rays. H. E. Stauss. *J.O.S.A.* 20. *pp.* 616–617, *Nov.*, 1930.—A prism method for determining indices of refraction of X-rays [see Abstract 1006 (1931)] allows of the comparison of values so obtained with those from the total reflection method. Values obtained with quartz and glass for MoKα radiation by the two methods are in good agreement, showing that the total reflection of X-rays is characteristic of the body of the reflector and is not influenced appreciably by surface conditions. C. B. A.

1555. Optics of the Reflection of X-Rays by Crystals. Part V. H. Seemann. *Ann. d. Physik*, 7. 6. *pp.* 633–649, *Dec.* 9, 1930.—Continuing previous work [see Abstract 1279 (1931)] the author discusses the reflection patterns which are obtained when X-rays from a point source fall on the crystal surface, in a "solid" cone of very wide angle of the order of 90° semi-angle. Reflection from the structure plane parallel to the surface gives an ellipse, parabola or hyperbola on the photographic plate, depending on the orientation of the latter. Reflections from structure planes inclined to the surface give traces which are not conic sections but sections of complicated ruled surfaces. The form of these is examined. A number of photographs of wide angle patterns obtained with rock-salt using copper K radiation illustrate the type of result obtained. W. S. S.

1556. Influence of Form and Polarity of Molecules on the X-Ray Spectrum of Liquids. Part III. J. R. Katz and J. Selman. *Zeits. f. Physik*, 66. 11–12. *pp.* 834–857, 1930.—Deals with the formation of two strong amorphous rings in the spectrum of liquids, the molecules of which are apparently of disc form. It is suggested that these molecules tend to arrange themselves in a manner similar to that observed with disc-formed colloid particles in colloidal solutions, *i.e.*, in parallel layers with a definite distance between the layers. Apparently small groups of molecules are formed in which the discs are arranged, not only parallel to one another, but so as to form something like a lattice. The arrangement seems to be like that in which a number of coins are piled one on the other to form a "roll." The axes of the different small rolls are apparently orientated in all sorts of different directions in the liquid. The higher the temperature the more indistinct is the effect of the disc form in the X-ray diagram. The question has been investigated, using a large number of organic compounds, the effect of the structure of the disc-shaped molecules being studied. When the molecules can be regarded as rigid discs the structure of the liquid can be looked upon as a transition state between a crystallised state and a truly amorphous one. A connection with the problems of the fluid-crystalline state and of stretched rubber appears probable. It seems that such liquids can be looked on as a special state of matter, though they are true liquids. [See also Abstract 948 (1928).] H. N. A.

1557. Hardness of X-Rays. L. Grebe and W. Schmitz. *Zeits. f. wiss. Phot.* 29. 1–12. *pp.* 129–133, 1930.—The blackening of a photographic plate due to X-rays is recorded on the same plate, once by various time exposures and then through various thicknesses of aluminium, and the blackenings are then measured photoelectrically. This gives a double scale from which the quality of the material may be gauged when the thickness is known or *vice versa.* E. E. F. d'A.

1558. Measurements with an X-Ray Apparatus for 400 kV. H. Herrmann and R. Jaeger. *Zeits. f. techn. Physik,* 11. 11. *pp.* 461–465, 1930. *Paper read before the Deut. Phys. u. Math., Königsberg, Sept.,* 1930. *Phys. Zeits.* 31. *pp.* 1061–1062, *Dec.* 1, 1930.—The penetrating power of extremely hard X-rays has been investigated using a very sensitive ionisation apparatus. The half-value layer in copper increases approximately linearly with voltage. Whereas for the usual therapeutic voltage of 200 kV. and a primary filter of 1 mm. of copper a half-value layer of 1 mm. of copper is observed, for 400 kV. and primary filter of 3 mm. copper, the half-value layer is 4 mm. of copper. In order to obtain data comparable with those for γ-rays the absorption of very hard X-rays in lead was also investigated. The absorption coefficient in lead sinks from 22 cm.$^{-1}$ at 200 kV. to about 4 cm.$^{-1}$ at 400 kV. This value approximates to the value for the softer components of the γ-rays from RaC for which the value is 1·5 cm.$^{-1}$. From the absorption curve it is shown that in order to obtain the same protective value in each case, 4 mm. of lead suffices at 200 kV. whereas 8 mm. of lead is required at 300 kV. and 14·5 mm. lead at 400 kV. W. V. M.

1559. X-Ray Spectra of Gases. K Series of Krypton and Xenon. A. Dauvillier. *Comptes Rendus,* 191. *pp.* 937–939, *Nov.* 17, 1930.—A technique has been developed for the excitation of the X-ray spectra of free atoms by an electronic beam. The K series of krypton and xenon have been measured, giving for Kr(36): $\alpha_1\alpha_2$, 978, and β, 875; and for Xe(54): $\alpha_1\alpha_2$, 417, and β, 360. F. J. W.

1560. Absorption of X-Rays. Part II. M. Ishino and S. Kawata. *Kyoto Coll. Sci., Mem.* 13. *pp.* 375–381, *Nov.,* 1930. *In English.*—By the method previously described [see Abstract 1623 (1928)] mass and true mass absorption coefficients (μ/ρ and τ/ρ) have been determined or revised for MoKα and Kβ, and WLγ, and Lβ, radiation for (more or less) nineteen elements, μ/ρ for hydrogen for MoKα and MoKβ being taken respectively as 0·466 and 0·440, and σ/ρ as before determined. Curves plotting true gramme-atomic absorption coefficients $\tau A/\rho$ against the atomic number Z are given, and it is shown that no such relation holds as $\tau A/\rho = c\lambda^p Z^q$, where c, p and q are constants. C. A. S.

1561. Partial Absorption of X-Rays. B. B. Ray. *Zeits. f. Physik,* 66. 3–4. *pp.* 261–268, 1930.—Monochromatic X-rays are passed through carbon, nitrogen and oxygen, and the partially absorbed lines are observed. These only occur in the direction of transmission of the primary wave, indicating that in the interaction between a quantum and a bound electron the former loses a part of its energy and an equivalent part of its momentum during its passage through the medium, and that the electron is raised from one level to another or removed completely from the atom. The remaining energy must then be propagated with a new momentum in the original direction as a wave of lower frequency. C. B. A.

1562. L-Absorption Edges of the Heavy Elements. A. Sandström. *Zeits. f. Physik*, 66. 11–12. *pp*. 784–789, 1930.—From measurements made by the author [see Abstract 869 (1931)] on the L-absorption spectra of the elements 74 (tungsten) to 92 (uranium) and by Idei [see Abstract 1566 (1931)] on the L-emission spectra, it is concluded that the L-absorption edges do correspond to transitions of electrons from the L-level to the first incompletely occupied level outside. A. C. M.

1563. X-Ray Absorption in Gases. W. W. Colvert. *Phys. Rev.* 36. *pp*. 1619–1624, *Dec*. 1, 1930.—X-ray spectral lines reflected from a platinum surfaced mirror and by a calcite crystal have been used for absorption measurements with neon, sulphur dioxide, chlorine and argon. The double reflection gives a more nearly homogeneous beam, since the mirror greatly reduces the higher orders of the shorter wave-lengths. The results are summarised in the following table:

Mass Absorption Coefficients.

	0·496 Å.	0·561 Å.	0·631 Å.	0·710 Å.	1·389 Å.	1·539 Å.	2·288 Å.
Ne	0·84	1·20	1·69	2·50	16·0	23·4	75·5
Al	1·96	2·71	3·82	5·32	37·3	50·7	149·6
SO_2	1·92	2·67	3·60	5·55	38·5	51·8	162·6
S(Calc)	3·40	4·64	6·89	9·96	66·4	88·4	284·0
Cl	4·14	5·76	8·18	11·52	76·9	102·7	315·0
A	5·06	6·89	9·80	13·0	85·7	114·0	339·4

Author.

1564. Regularities of X-Ray Spark Spectra. S. Idei. *Tohoku Univ., Sci. Reports*, 19. *pp*. 551–558, *Dec.*, 1930. *In English*.—The values of $\Delta\sqrt{\frac{\nu}{R}}$ and $\Delta\frac{\nu}{R}$ between the so-called spark lines in the X-ray spectra and their main line have been studied as functions of the atomic number, and it is found that $\Delta\sqrt{\frac{\nu}{R}}$ is nearly constant and $\Delta\frac{\nu}{R}$ varies linearly with the atomic number. By these regularities it was possible to correlate certain spark lines found by several investigators. Author.

1565. Fine Structure of Moseley Curves for Energy Levels in Lower Elements. S. Idei. *Tohoku Univ., Sci. Reports*, 19. *pp*. 641–649, *Dec.*, 1930. *In English*.—The fine structure of the Moseley curves for the energy levels in the lower elements has been studied by a simple method proposed by the author. Many discontinuities in the Moseley curves studied, corresponding to the stepwise process of atomic building, were brought out in a striking manner. Some considerations are put forward on the screening effect of other electrons. Author.

1566. Precise Measurements of the L-Group of the X-Rays in the Heavy Elements. S. Idei. *Tohoku Univ., Sci. Reports,* 19. *pp.* 559–639, *Dec.,* 1930. *In English.*—The author, using Siegbahn's technique, has determined accurately the wave-lengths of a large number of X-ray lines in the L spectra of Ta, W, Ir, Pt, Au, Tl, Pb, Bi, Th and U. The original paper should be consulted for the wealth of experimental material contained in it. [See also following Abstract.] W. V. M.

1567. Fine Structure of Moseley Curves for M-Absorption Edges in Heavier Elements. S. Idei. *Tohoku Univ., Sci. Reports,* 19. *pp.* 651–652, *Dec.,* 1930. *In English.*—In a previous paper [see preceding Abstract] it has been shown that the discontinuities in the Moseley curves, for the L-absorption edges and for some emission lines in the L- and the M-series, were to be seen at Pt(78) and near Th(90). In this note such discontinuities are confirmed for the M-absorption edges by using the method of the modified Moseley curves. AUTHOR.

1568. Fine Structure of K-Absorption Spectrum of Selenium. S. Idei. *Tohoku Univ., Sci. Reports,* 19. *pp.* 653–658, *Dec.,* 1930. *In English.*—The K-absorption spectrum of selenium was investigated. The fine structure was found and measured. The effect of chemical combination on the principal K-absorption limit has been found to be negligibly small. AUTHOR.

1569. Angular Intensity Distribution of Continuous X-Ray Spectrum. Part III. Y. Sugiura. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 281. *pp.* 37–39, *Dec.* 20, 1930.—The question whether the retarded coordinate or current matrix element is responsible for the angular intensity distribution of continuous X-ray spectrum, is discussed more in detail than in the previous part [see Abstract 3158 (1930)]. AUTHOR.

1570. Polarisation of the Continuous X-Rays from Single Electron Impacts. B. Dasannacharya. *Phys. Rev.* 36. *pp.* 1675–1679, *Dec.* 15, 1930.—Experiments are described on the polarisation of continuous X-rays from targets of aluminium sheets varying in thickness from 6 to 250×10^{-5} cm. The velocities of the exciting electrons corresponded to voltages from 27 to 57 kV. It was found that the polarisation increased exponentially with decreasing thicknesses, suggesting perhaps a nearly complete polarisation for a thickness of about 6×10^{-6} cm. The polarisation diminished with an increase in the velocity of the exciting electrons. The theory of the polarisation of continuous X-rays developed by Sugiura [see Abstract 1480 (1930)] seems to be in conformity with the experimental results obtained in the experiments described. AUTHOR.

1571. Diffraction of X-Rays in Liquids: Effect of Temperature. E. W. Skinner. *Phys. Rev.* 36. *pp.* 1625–1630, *Dec.* 1, 1930.—The effect of temperature upon X-ray diffraction has been examined for several organic liquids. The peaks shift in the intensity-diffraction angle curve toward smaller angles with increase in temperature, which varies in amount in different planar spacings in the same liquid. The peak intensity varies with temperature differently for the different spacings in a single liquid, the principal maxima showing a decrease in the intensity for some liquids (class I), and an increase in the intensity for other liquids (class II) with increase in temperature. A greater diffuseness of the principal maxima was found at high temperatures, attaining a greater magnitude for class I liquids. The percentage increase in peak width per degree change in temperature is greater for class II than for class I. Boiling had no effect on diffraction phenomena. Increased scattering at small angles was noted at high temperatures, the effect being greater for class II. The evidence favours strongly the cybotactic space group condition of liquids, and indicates that in some of the liquids space rearrangement within these groups takes place with changes in temperature. It may be said there is a change in molecular shape. Furthermore, within the groups of some liquids, expansion is apparently different in different directions, or internally anisotropic. AUTHOR.

1572. Intensity of Total Scattering of X-Rays by Monatomic Gases. Y. H. Woo. *Nat. Acad. Sci., Proc.* 16. *pp.* 814–816, *Dec.,* 1930.—In this paper a calculation is made [see also Abstract 3164 (1930)] of the intensity of the scattering of X-rays by helium and argon and the results compared with the experimental data recently obtained by Barrett [see Abstract 2738 (1928)]. The agreement between theory and experiment is very satisfactory. It is claimed that by the method of calculation outlined, the scattering by all monatomic gases and vapours can be approximately estimated. H. H. Ho.

1573. Multiple Scattering in the Compton Effect. J. W. M. Dumond. *Phys. Rev.* 36. *pp.* 1685–1701, *Dec.* 15, 1930.—The case where hard radiation is scattered twice by light atoms (in which the unmodified radiation is negligible at nearly all scattering angles) is considered in detail, and the ratio (doubly scattered energy)/(singly scattered energy) shown to be $9\sigma r\mathrm{R}(\theta)/32$, where σ is the linear scattering coefficient for the material of the scattering sphere, r its radius, θ the angle of single scattering, and $\mathrm{R}(\theta)$ a complicated function of θ equal usually to about $2\cdot 5$. Curves showing spectral distribution due to doubly modified double scattering for various angles of primary scattering are given. The effects of excess unmodified and diminished modified scattering on these results is discussed qualitatively. It is concluded that: For MoK radiation scattered by a sphere of graphite, 1 cm. radius double scattering is about 14 % of single; triple and higher scattering can usually be completely neglected; twice modified doubly scattered radiation may contribute a faint line at $\Delta\lambda = 2(h/mc)(1 + \cos \frac{1}{2}\theta)$; such radiation when hard contributes a spectral band of breadth $4(h/mc) \cos \frac{1}{2}\theta$; and once-modified doubly scattered radiation may cause a slight broadening of the Compton line except near $\theta = 0$ or 180°. C. A. S.

1574. Spectrum of Radiation from a High Potential X-Ray Tube. C. C. Lauritsen. *Phys. Rev.* 36. *pp.* 1680–1684, *Dec.* 15, 1930.—A spectrograph of the Seemann type has been constructed for the purpose of investigating the radiation from the h.t. X-ray tube at the California Institute. A typical spectrogram obtained with 600 kV on the tube is presented. The photometer record shows a continuous spectrum with its maximum intensity at about 200 kV and a short wave-length limit in the neighbourhood of 600 kV. The range covered is roughly from 100 to 20 X-units. It is proposed to use the apparatus for determining absorption coefficients by photographing the spectrum of radiation which has passed through an absorbing screen. No anomalies of any kind have been observed so far. AUTHOR.

RADIOACTIVITY.

1575. Possible Radioactivity of Lead. G. Guében. *Ann. Soc. Sci. de Bruxelles,* 50. *pp.* 117–121, *Dec.* 22, 1930.—From observations on pieces of lead taken from the roof of a building, it has been suggested by (Miss) S. Maracineanu that lead can acquire radioactive capacity from exposure to the sun's rays. Other observers from tests made upon lead from old roofing [see Abstracts 2571 and 2572 (1930)] have come to the conclusion that the behaviour of the metal and also of copper and zinc in similar circumstances is due to adsorption of radioactive emanations from the air and from rain-water. The author has made experiments with discs of pure lead (99·75 %) exposed to the atmosphere, to ultra-violet rays from a mercury lamp in quartz, to X-rays, and to penetrating rays from radium, and found that none of these modified the behaviour of lead as regards radioactivity. The plate exposed in the open air had probably not a sufficiently long exposure—it lasted seven months—to acquire a radioactive deposit which could be detected. [See also following Abstract.] J. J. S.

1576. Observations on Radioactivity. (Miss) S. Maracineanu and F. Běhounek. *Phys. Zeits.* 31. *pp.* 1032–1039, *Nov.* 15, 1930.—Miss Maracineanu comments on Běhounek's criticisms of her papers on radioactivity in which she seeks to prove that solar radiation excites radioactivity in lead. The conclusion is drawn that lead when long insolated acquires the property of emitting an absorbable radiation analogous to α-rays. In the present paper she supports her observations and conclusions. **Behounek** quotes the results of various investigators which tend to negative her hypothesis and supports the view that the radioactivity observed in lead after long exposure to the air is due to the adsorption from the atmosphere of atoms of Ra A, B, C, which are present in it and form a fixed deposit on the exposed surface of the lead. In a paper following **(Miss) Maracineanu** makes a few short remarks on Běhounek's paper. [See also preceding Abstract.] J. J. S.

1577. Recoil Atoms in a Gaseous Medium. L. Goldstein. *Comptes Rendus,* 191. *pp.* 1450–1452, *Dec.* 29, 1930.—The curve showing the relation between yield of activation and pressure [see Abstract 1090 (1930)] shows a rapid rise to a maximum of 50 % for a pressure of about 2 cm. mercury, followed by an asymptotic decline to about 26 % for pressures in excess of 45 cm. It is suggested that this is due to the maximum occurring when the field is just strong enough to bring all recoils atoms on to the electrode, the subsequent decline being caused by increased ionic density due to increased pressure resulting in more complete utilisation (in ionisation) of the α-particles. This view is supported by experimental results showing the yield with saturation current at various pressures on the kathode (83 %) and anode (15 %), both values being independent of pressure. Voltages in excess of those required to produce the saturation current are accompanied by a decline in the yield on the kathode due to commencement of ionisation by collision. A similar result is caused by increased ionic density due to irradiation by a Coolidge tube. In both cases yield on the anode is unaffected. C. A. S.

1578. Pleochroic "Giant" Haloes in Cordierite. M. S. Krishnan and C. Mahadevan. *Indian Journ. Phys.* 5. *pp.* 669–680, *Dec.* 31, 1930.—In the course of the examination of more than 200 haloes contained in 20 thin sections of cordierite-gneiss from Madura District, South India, a few "giant" haloes—those having dimensions larger than for normal ranges of α-particles in U and Th series—were observed, in addition to the normal haloes. In view of the good agreement of the dimensions of these haloes with the values theoretically calculated for the long-range α-particles, it is conclusively shown that they correspond to the ranges of 9·3 cm. for RaC′ and 11·5 cm. for ThC′ in air. The richness of this cordierite in radioactive materials and the long period of activity of the latter (since Archæan times) have contributed to the full development and preservation of the structures in these haloes. Reference is made to the relationship of the intensity of pleochroism of the haloes to the directions of absorption in the crystalline medium in which they develop. AUTHORS.

1579. Higher Approximations of Born's Collision Method. C. Moller. *Zeits. f. Physik*, 66. 7–8. *pp.* 513–532, 1930.—In an earlier paper [see Abstract 3754 (1930)], on the scattering of α-particles by atom nuclei, the author calculated the first approximation of the Born collision method. The calculation of the higher approximations can be carried out comparatively easily if the work is done, as by Dirac, in impulse space instead of in coordinate space. It is shown how the imperfectly founded use of Cauchy's chief values in the theory can be avoided or in most cases justified. The second approximation for α-ray scattering is explicitly calculated. This is for all velocities occurring in nature of the same order of magnitude as the first approximation, so that Born's method for α-rays must be considered as unsuitable. Then the second approximation of the elastic collisions for electron scattering is estimated and a condition for it stated which satisfies the first approximation and is also plausible from elementary considerations. J. J. S.

1580. New Method of Radioactive Investigation of Pulverised Substances. W. Šebesta. *Zeits. f. Physik*, 66. 9–10. *pp.* 598–612, 1930.—The α-ray method, distinguished by its great sensitiveness, may be developed into a quantitative method of measurement free from objections. The pulverised substance examined is mixed with a small pulverised mass of a suitable normal preparation and the change thereby caused in the gas conductivity produced in the α-ray condenser is measured. J. J. S.

1581. Anomalous Scattering of α-Particles by Light Nuclei. E. Guth and T. Sexl. *Zeits. f. Physik*, 66. 9–10. *pp.* 577–580, 1930.—Gives a method for the exact calculation of the anomalous scattering of α-particles from a Gamow, Gurney, Condon potential field. The problem is dealt with in a manner analogous with that employed in optical refraction problems, using developments in series. This method has already been used by Gordon in an exact solution of the Coulomb problem. The present case is dealt with by means of wave-mechanics. H. N. A.

1582. Relation Between Emission of α-Particles and γ-Rays. (Mme.) P. Curie. *Comptes Rendus*, 191. *pp.* 1055–1058, *Dec.* 1, 1930.—It is shown that the formula for the proportion (N) of long-range α-particles emitted in the transformations RaC to RaC′ and ThC to ThC′, deduced by Gamow [see *Nature*, 126. p. 397, 1930] on the theory that these particles correspond to a higher quantum level in the nucleus, is more accurately given by the equation $N = p\lambda/(\lambda + \Theta)$, where p is the proportion of excited atoms, λ the probability of emitting a long-range particle, and Θ that of returning to the normal state by emitting a quantum of radiation followed by an α-particle of normal range. This agrees with Gamow's formula, $N = p\lambda/\Theta$, if N is small compared with p, and by aid of Ellis and Aston's results [see Abstract 537 (1931)] gives $\Theta = 1 \cdot 5 \times 10^{13}$/sec. for RaC′. The case of ThC′ is complicated by the fact that the γ-rays appear to be produced from ThC″ [see Abstract 231 (1930)]. The theory is considered to be nearly but not entirely satisfactory. C. A. S.

1583. Artificial Excitation of Nucleus γ-Rays. W. Bothe and H. Becker. *Zeits. f. Physik,* 66. 5–6. *pp.* 289–306, 1930.—A series of elements and compounds were bombarded with the α-rays of a strong polonium preparation and examined for secondary γ-rays. With Li, Be, B, F, Mg and Al, a γ-radiation was observed, the yields being similar to those in the case of atom disintegration. The penetrating power of the B and Be radiation was found to be of the order of magnitude of the hardest radioactive γ-rays. The hard secondary radiation of lead noted by Slater could not be observed. The approximate course of the excitation function of the Be radiation was established. A distinct dependence of the hardness of the Be radiation upon the α energy could not be found. The B radiation was not perceptibly anisotropic. The possibilities as to the origin of the γ-emission and the connection between γ-radiation and atom disintegration are discussed with the help of Gamow's model of the nucleus. J. J. S.

1584. Absorption Coefficients of the γ-Radiation from Radium D and Radium E. Susanne Bramson. *Zeits. f. Physik,* 66. 11–12. *pp.* 721–740, 1930.—By absolute current measurements a determination was made of the ionisation produced by the γ-rays from RaD and RaE after passage through various thicknesses of filter. Hence the absorption coefficients of the separate components of the radiation were found. The absorption coefficients of the γ-rays from RaD in Al and Cu were $\mu_{Al} = 1 \cdot 17$ cm.$^{-1}$ and $\mu_{Cu} = 30 \cdot 1$ cm.$^{-1}$. With RaE in Cu, two components of radiation were found with the absorption coefficients $\mu_{Cu} = 7 \cdot 4$ cm.$^{-1}$ and $\mu_{Cu} = 0 \cdot 85$ cm.$^{-1}$. The first component is the K_α radiation of the resultant product polonium excited by the primary β-rays of RaE; the second component is derived from the nucleus of RaE. It is estimated that with RaD from 100 disintegrating atoms $3 \cdot 1 \pm 1 \cdot 2$ γ-quanta are sent out. If the absorption in the atom itself, as given by Kikuchi, is 95 %, then each decaying RaD atom nucleus emits one γ-quantum. The number of quanta sent out by RaE in the form of nucleus radiation amounts to $0 \cdot 5 \pm 0 \cdot 25$ per 100 decaying atoms, and for the K radiation of the succession product, $1 \cdot 1 \pm 0 \cdot 5$. J. J. S.

1585. Thunderstorms and Penetrating Radiation. B. F. J. Schonland. *Roy. Soc., Proc.* 130. *pp.* 37–63, *Dec.* 2, 1930.—A description is given of an ionisation-electroscope suitable for the measurement of small and rapid change in the intensity of the penetrating rays. Measurements made at Johannesburg in both fine and thundery weather show that: (1) Fine-weather ionisation shows fluctuations to be attributed to probability fluctuations in the number of ionising particles; (2) No "run-away" electrons in the negative fields below thunder-clouds could be detected. They may have been stopped by nuclear collision before

reaching the ground; (3) There is a reduction in the intensity of the radiation when active thunder-clouds are overhead. This is the only thunderstorm effect observed; (4) The reduction is greatest for those storms for which there was evidence that the upper positive charge was in excess. This suggests that the primary penetrating radiation is not of the β-ray type but is either positively charged particles or ultra-γ-rays.
W. V. M.

1586. Cosmic Radiation Measurements in North Sweden. A. Corlin. *Phys. Zeits.* 31. *pp.* 1065–1071, *Dec.* 1, 1930. *Paper read before the Deut. Physikertag., Königsberg, Sept.*, 1930.—A further account of observations at Abisko [see Abstract 538 (1931)] between October 16, 1929, and January 13, 1930, and at Torne Träsk on the ice in April and May 1930. In these later experiments the apparatus was in an iron screen of 11 cm. thickness at the base and 6 cm. thickness at the sides. Sidereal time curves for high and low states of the barometer and for hours of disturbed and undisturbed magnetic conditions are given. The results of the ionisation measurements confirm those of Steinke carried out at Muottas Muraigl, in Switzerland, and at Königsberg. The decrease of the ionisation with increase of latitude given in the account of the earlier observations has to be somewhat reduced as the air-pressure coefficient used was too high.
J. J. S.

1587. Constancy of Cosmic Radiation and its Relation to Meteorology. R. A. Millikan. *Phys. Rev.* 36. *pp.* 1595–1603, *Dec.* 1, 1930.—Mean cosmic-ray intensities have been measured with much precision both at Pasadena, California (latitude 34) and at Churchill, Manitoba (latitude 59), the latter a distance of 730 miles from the North magnetic pole. The observed equality in these intensities indicates that these rays enter the earth's atmosphere as photons rather than as streams of electrons. Evidence is presented that the incoming rays are of a uniform intensity in all directions and in all latitudes, the small and apparently erratic fluctuations found by many observers at different stations arising simply from eruptions, waves, or ripples which change the thickness of the atmospheric blanket interposed between the source and the observer. The cosmic-ray electroscope thus acquires significance as a meteorological instrument. The influence of these rays in the maintenance of the earth's charge is considered.
AUTHOR.

1588. Geiger-Müller Tube as a Quantitative Ion-Counter. J. A. van den Akker. *Rev. Sci. Instruments*, 1. *pp.* 672–683, *Nov.*, 1930.—It was found that the new Geiger-Müller tube [see Abstracts 1237 (1929) and 1099 (1930)] is a quantitative detector of individual ions if certain precautions are observed. A bare polished wire along the axis of the tube gives satisfactory results if the resistance and capacity used in the arrangement are given suitable values. The Geiger-Müller tube is quantitative only where the rate of counting is moderate and is particularly accurate where the rate of counting is very low. The spurious discharges which enter at higher rates of counting seem to be part of the intrinsic nature of the Geiger-Müller tube in its present form; even for large tubes the rate of counting can perhaps never exceed about 300 per min. The spurious discharges may be caused by the momentary rise of the field gradient to abnormally high values due to temporary disruptions of the ion layers in a tube.
J. J. S.

HEAT.

1589. Freezing Point of Nickel as a Fixed Point on the International Temperature Scale. H. T. Wensel and W. F. Roeser. *Bureau of Standards, J. of Research,* 5. *pp.* 1309–1318, *Dec.,* 1930.—The freezing point of nickel was determined by measuring with an optical pyrometer the ratio of brightness of red light of wave-length 0·6533 μ emitted by black bodies at the freezing points of nickel and gold, respectively. The nickel was frozen in magnesia crucibles *in vacuo.* The freezing point was found to be 1455° C. on the International Temperature Scale with an uncertainty of 1°, based on the value 1063° C. for the freezing point of gold and 1·432 cm. deg. for C_2. The temperature coefficient of resistance of the two separate ingots of nickel used was approximately 0·0067 in the interval 0° to 100° C. The chemical analyses indicated the purity of the nickel as 99·94 %. The importance of the nickel point in optical pyrometry is discussed. The freezing point of pure nickel in magnesia crucibles was found to be very satisfactory as a fixed point in accurately extending the high-temperature scale beyond the platinum point. AUTHORS.

1590. Experimental Study of the Absolute Temperature Scale. Part I. Construction of Platinum Resistance Thermometers. J. A. Beattie, D. D. Jacobus and J. M. Gaines, Jr. *Am. Acad., Proc.* 66. *pp.* 167–184, *Dec.,* 1930.—By international agreement the platinum resistance thermometer has been adopted as the instrument for the interpolation of temperatures on the thermodynamic scale between — 190° C. and + 600° C. In the modern resistance thermometer the wire is wound on a mica frame and enclosed in a glass, quartz or metal sheath. Details are given of the construction of 25 ohm platinum thermometers of the three types: (1) the Callendar mica-cross; (2) the Bureau of Standards calorimetric, which has a very small time-lag in responding to thermal changes; (3) the Strainfree type, designed to avoid strain due to heating and cooling of the thermometer. Descriptions are given of methods of compensating for lead resistance, construction of the templets, construction and winding of the mica forms, the casings, assembly, materials and annealing. A commutator for connecting any number of potential-terminal type resistance thermometers to a Mueller thermometer bridge is also described. T. B.

1591. Resistance Thermometers for General Chemical Use. C. G. Maier. *J. Phys. Chem.* 34. *pp.* 2860–2868, *Dec.,* 1930.—Advantages of copper for resistance thermometers are pointed out and a type is described which eliminates hysteresis and drift due to differential thermal expansions. A method is given for the precise calibration of a copper resistance thermometer from two accurate fixed points and two coefficients of less accuracy. Between 0° and 32·4° C. the resistance of a thermometer constructed of commercial copper wire was found to obey the parabolic expression $R_s = R_0(1 + 4\cdot 26399.10^{-3}s + 3\cdot 753.10^{-7}s^2$, where R_s is the resistance at temperature s, and R_0 that at 0° C. A modified type of resistance thermometer suitable for general chemical laboratory use is

described, which is the practical equivalent of several hundred multiple junction thermels, and which requires only simple electrical instruments.
AUTHOR.

1592. Optical Pyrometry. A. C. Egerton and M. Milford. *Roy. Soc., Proc.* 130. *pp.* 111–119, *Dec.* 2, 1930.—A description of experimental work undertaken for the investigation of the carbon arc at high pressures, and the modifications necessary to the disappearing filament pyrometer for this purpose. The first essential is to magnify the source of light in order to obtain a cone of rays to fill the aperture completely. The method adopted was similar to that, found quite independently, of Fairchild and Hoover. The advantages of such an arrangement are discussed fully. A monochromatic filter, made from a "didymium glass," which transmits a band of light between 5740 and 5600 Å., is described. The calibration of the pyrometer by simple methods is reviewed, two methods being discussed, namely, the use of a wedge as a black-body source or a platinum tube provided with a small hole. The suggestion of Mendenhall regarding the use of an electrically-heated wedge as a black-body source is noted, wherein he showed that for a wedge of 10°, with reflecting surfaces made of platinum, the emission is 99·8 % black. In the present work the wedge was formed of platinum foil (0·001 cm. thick), measuring 5 × 0·5 cm., the angle being 10°. A black-body source, easily constructed, was thus obtained, upon which the magnifying pyrometer could be standardised. Details of the wedge mountings are given. In the case of the platinum tube the temperatures are determined by melting small pieces of metal on the outside of the tube (or of the wedge), or preferably by hanging a wire down the middle of the tube. Two monochromatic filters are used with advantage so that the colour temperature may be determined. It is pointed out that if the source is a grey body, in the visible region of the spectrum, accurate observations of the brightness temperature in two wave-lengths will lead to a determination of the colour temperature of the source, which usually sets a high limit to the true temperature, as the brightness temperature sets a low limit. For these reasons the authors point out that it is useful to provide the pyrometer with at least two monochromatic filters.
S. G. B.

1593. Specific Heats of Gases at High Pressures and High Temperatures. Part II. N. W. Krase and B. H. Mackey. *Am. Chem. Soc., J.* 52. *pp.* 5111–5114, *Dec.*, 1930.—The former paper [see Abstract 2235 (1930)] dealt with apparatus suitable for direct calorimetric measurements at ordinary temperature, and up to 1000 atmos. pressure. The present paper describes a new calorimeter for the same pressures, but available for use up to 350° C. A typical set of values for nitrogen at 500 atmos. shows the molar heat capacity falling from 9·12 at 30° C. to 8·13 at 150° C.
J. H. A.

1594. Calculation of Heats of Distillation. M. Barthel. *J. de Physique et le Radium*, 1. *pp.* 411–415, *Dec.*, 1930.—A study of the dynamic equilibrium between a vapour and a gas flowing in opposite directions through a heated tube. An expression is found for the heat interchange, and it involves only the initial and final concentrations of the vapour. The method is in effect to consider a slight displacement from the equilibrium values, keeping the energy, the pressure and the entropy constant.
J. H. A.

1595. Alleged Anomalies in the Fusion Diagrams of Some Binary Systems. N. A. Puschin and I. I. Rikovski. *Zeits. f. phys. Chem.* 151. *Abt. A.* 3-4. *pp.* 257-268, *Dec.*, 1930.—Thermal analysis of the systems m-dinitrobenzene-o-phenylene-diamine, m-dinitrobenzene-m-phenylenediamine, benzamide-m-nitrophenol, benzamide-p-nitrosodimethylaniline, benzophenone-picric acid, shows that in the fusion diagram in each case the liquidus consists of two lines intersecting in a single eutectic. In the system m-dinitrobenzene-naphthalene there is only one eutectic, but the course of the liquidus on the nitrobenzene side is affected by a transformation. In none of the cases investigated is there in the liquidus a horizontal portion joining two eutectic points, as suggested by Kremann and his co-workers. A. J. M.

1596. Automatic Maintenance of Solid-Liquid Equilibrium in a Metal. P. A. Anderson. *Rev. Sci. Instruments,* 1. *pp.* 764-767, *Dec.*, 1930.—The method adopted depends upon the fact that the specific resistance of a molten metal at the melting point is approximately twice that of the solid metal at the same temperature, while the volume change on fusion is of the order of 5 to 10 %. A constant d.c., called the control current, is passed through a mass of the metal (zinc) contained in a furnace thermostat which is wound with nichrome wire. Potential leads are taken from the inside of the metal to a reflecting galvanometer, the reflected light from which can fall upon a photoelectric cell. The furnace heating current—110 volts a.c.—is then controlled with the aid of this photoelectric cell and a thyratron mercury-arc tube. The apparatus operates automatically. The illuminated photocell passes a negative charge to the grid of the arc tube, the arc is interrupted and the current in the furnace is decreased by a small fraction of its full value. Some molten zinc then solidifies, causing the resistance of the bath to fall off and then the galvanometer spot moves away from the photo cell and the full current is restored. W. C. S. P.

1597. Water-Vapour Pressure Over Ice. C. Dei. *Accad. Lincei, Atti,* 12. *pp.* 119-124, *Aug.*, 1930. *N. Cimento,* 8. *pp.* 71-77, *Feb.*, 1931.—Finds the discharge potential corresponding to each vapour density and from the curve obtained finds the vapour density, and hence the vapour pressure, of water at low temperatures. E. E. F. d'A.

1598. Equations for Vapour Pressures and Latent Heats. L. J. Gillespie. *Am. Acad., Proc.* 66. *pp.* 153-164, *Dec.*, 1930.—A vapour pressure equation which holds for such a general case as that of a solid compound, one component of which is gaseous (*e.g.*, $BaCl_2$, $8NH_3$), is calculated by purely thermodynamic methods. Various integrals which occur in it are evaluated approximately, giving equations of various degrees of approximation. J. H. A.

1599. Critical Constants of Carbon Dioxide-Oxygen Mixtures. H. S. Booth and J. M. Carter. *J. Phys. Chem.* 34. *pp.* 2801-2825, *Dec.* 1930.—This investigation was undertaken since the medical profession have come to demand mixtures of CO_2 and O_2 varying from 5-30 % CO_2. Apparatus for the study of critical phenomena of gas mixtures at low temperatures has been designed and constructed. It has been found that mixtures containing 50 % or less of CO_2 should not separate into two phases, or otherwise lose their uniformity, under any ordinary conditions of shipping or storage. The mixture containing 50 % CO_2 cannot be liquefied at all above − 8·4° C., and cannot be completely liquefied at temperatures above − 35·7° C. The mixtures containing less CO_2 liquefy at even lower temperatures. The existence of a discontinuity in the critical curve of the mixture has been shown; it extends from mixtures containing approximately 62 % oxygen to those containing 97 % oxygen. A discontinuity is also present in the curve of the maximum temperatures of condensation; it extends from mixtures containing approximately 88–98 % of oxygen. The solubility of solid CO_2 in liquid oxygen near its critical point has been demonstrated, and it is estimated that there is about 3 % of CO_2 at − 115° C. An explanation of the retrograde phenomena is also given. H. H. Ho.

1600. Equation of State Explicit in the Volume. G. Scatchard. *Nat. Acad. Sci., Proc.* 16. *pp.* 811–813, *Dec.*, 1930.—Kinetic considerations always lead to an equation of state giving the pressure as a function of the concentration and temperature, but for many purposes it is more convenient to know the molal volume as a function of the pressure and temperature. Beattie [see Abstract 2240 (1930)] has previously indicated how the constants may be obtained from p,V,T data and his equation is now replaced by another, *viz*:

$$V/n = RT/p + \beta/RT + [\gamma/(RT)^2 - \beta^2/(RT)^3]p + [\delta/(RT)^3 - 3\beta\gamma/(RT)^4 + 2\beta^3/(RT)^5]p^2,$$

which has a considerable advantage in every case except nitrogen, and there the deviation is less than 0·3 % at 100 atmospheres. The equation, however, is not satisfactory at extremely high pressures, even for the more perfect gases, and should not be used over a higher pressure range without testing its accuracy. H. H. Ho.

1601. Van der Waals' Equation. E. Neusser. *Phys. Zeits.* 31 *pp.* 1041–1051, *Dec.* 1, 1930.—The coefficients which appear in van der Waals' equation are regarded as being dependent on temperature and pressure and evaluated from two measured volumes at the same temperature and neighbouring pressures. It is found that R = 0·082051 per atmosphere deg. mol. and T_0 = 273·20° for the absolute temperature of the ice point. The results for the re-evaluation of the experimental data for hydrogen and carbon dioxide are given in diagrammatic form. Distortion is found in the liquid-vapour coexistence region and a peculiar temperature influence is established which disappears at high pressures and high temperatures. Another distortion is found for hydrogen between 50° and 100° Abs. The critical constants are calculated for hydrogen. Vapour pressure calculations for carbon dioxide are possible between 0° and 30° C., and also of the approximate critical data. The co-volume and cohesion pressure of liquid and vapour pass over continuously into each other and appreciably decrease at every temperature in the neighbourhood of the boiling pressure. H. H. Ho.

1602. Thermodynamics of Mixtures. V. Fischer. *Zeits. f. Physik,* 66. 3–4. *pp.* 269–279, 1930.—For dilute solutions of a gas in a liquid, the osmotic pressure of the dissolved gas is found to be equal to the pressure, which in turn is equal to the absorption coefficient [see Abstract 3108 (1929)]. The theoretical deductions are supported by experimental data for the mixtures acetylene-acetone, acetylene-acetone-water, acetylene-acetone-ethyl alcohol, and acetylene-acetone-methyl alcohol. H. H. Ho.

SOUND.

1603. Fechner's Law and Its Significance in the Theory of Acoustic Errors of Observation and the Theory of Hearing. G. v. Békésy. *Ann. d. Physik*, 7. 3. *pp.* 329–359, *Nov.* 10, 1930.—In acoustical observations, the exactness of adjustment of the measuring apparatus surpasses the "threshold of discrimination"—a quantity which measures the change in the intensity of the excitation corresponding to the smallest change in the strength of the perception. Errors of observation are dependent on this threshold value, and the Gauss law of error no longer applies. From the first law of Fechner, according to which the threshold value is fixed by the structure of the nerves, a law of error was derived which received a great measure of confirmation from experiments on the comparison of sound intensities in two successive impulsive tones. From the second law of Fechner, according to which the smallest change in the intensity of perception is the same over the whole range of sensation, the dependence of the threshold value on the loudness of the sound is determined, and the results compared with those of Knudsen [see Abstract 2230 (1923)]. A close relation is found to hold between the senses of hearing and touch. The connection between excitation and perception, derived from Fechner's law, is completely proved, and it is also shown under what conditions the law holds. G. E. A.

1604. Acoustical Properties of Conical Horns. Part II. K. Satô. *Tokyo Univ. Aeronaut. Research Inst., Report No.* 64. *pp.* 261–285, *Nov.*, 1930.—A mathematical and experimental treatment of the sound field due to a conical horn with a simple sound source at its vertex. Numerical results obtained from the equation agree fairly well with experiments in which the measuring apparatus was put at the vertex of the cone and the sound source placed at the point under observation. [For Part I, see Abstract 895 (1929).] W. H. Ge.

1605. Effect of Constrictions in Organ Pipes. E. J. Irons. *Phil. Mag.* 10. *pp.* 945–953, *Nov.*, 1930.—Deals with the problem of designing an organ pipe capable of emitting a note lower than possible by an ordinary stopped pipe of the same length. The method suggested is to introduce constrictions, discs with a circular hole in the centre coaxial with the axis of the pipe, and a theoretical treatment is given together with experimental data. See also M. de Mons, French patent No. 621719 (1927). W. H. Ge.

1606. Acoustical Investigations of Musical Instruments. The Syakuhati. J. Obata and Y. Ozawa. *Phys. Math. Soc. Japan, Proc.* 12. *pp.* 285–299, *Dec.*, 1930. *In English.*—The recording arrangement employed consisted of a condenser-microphone, a seven-stage amplifier and a h.f. oscillograph. The syakuhati [see Abstract 1419 (1906)] is the most popular of all Japanese wind instruments. Its ordinary tones have pitch D289, F, G, A and C′. The octaves of these tones can be obtained, and the pitch of any note can be varied as described in the paper cited. Wave records were obtained for the notes as sounded by two expert players, and sound spectra are derived showing for each note the relative intensities of the harmonics contained up to the twelfth. In most cases the second harmonic is the most prominent, and in this respect the instrument differs distinctly from the flute, in which the fundamental greatly

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predominates. The "ro" note, produced by closing all five lateral openings, is the richest in tone and the most difficult to produce. It is characterised by a spectrum in which the third, fourth and fifth partials are present in appreciable amount. The other notes are also discussed. With instruments of different length, the shorter the pipe, the simpler is its sound spectrum. G. E. A.

1607. Period of Contact of a Hard Hammer with a Piano String. K. C. Kar and M. Ghosh. *Zeits. f. Physik*, 66. 5–6. *pp*. 414–424, 1930.—The hammer is formed by the spherical bob of a bifilar pendulum adjusted with its centre of gravity at the level of a horizontally stretched wire. A horizontal smoked glass plate with a motion below and parallel to the wire is touched by a fibre which projects downwards from the bob. When the bob is at rest in contact with the string, motion of the plate results in a straight-line trace on the plate. When the pendulum swings against the wire, and the plate moves, a curved trace is obtained simultaneously with a trace from a tuning-fork. The period of contact is given by the time-interval between the two points where the curved trace crosses the straight one. For a wire 150 cm. long, of linear density 0·58 gm./cm., and tension 12,671 gm., the period of contact varies from 0·027 sec. at 5 cm. from the end to 0·0825 sec. at the middle of the string. This period increases with the mass and speed of the hammer. Graphs are given of the variation of the ratio (period of contact at middle of string : vibration period of string) with the ratio (mass of string : mass of hammer). The results are in accordance with the authors' theory. [See Abstract 2611 (1930).] G.E.A.

1608. String Vibrations of Finite Amplitude. K. Schlesinger. *Zeits. f. techn. Physik*, 12. 1. *pp*. 33–39, 1931.—A theoretical treatment of large, plane, transverse vibrations of strings, taking into consideration the periodic increase in tension which results from the elastic stretch of the wire and the longitudinal motion of the supports. The supports are replaced by masses capable of harmonic vibration, and the general differential equation then admits of exact integration from which it is deduced that the overtones are inharmonic, and the frequency varies with the amplitude. The frequency is diminished by the mass of the support but increased by its elasticity, and under the combined action of these two effects resonance conditions are possible in which the frequency is constant with varying amplitude. Experiments are described in which vibrations of amplitude up to 4 % of the length of the string were photographed; good quantitative agreement with theory was obtained. G. E. A.

1609. Diffractive Reflection and Scattering of Ultrasonic Waves. Their Influence on Torsion-Pendulum Measurements of Sound Intensity. R. W. Boyle and J. F. Lehmann. *Canad. J. of Research*, 3. *pp*. 491–509, *Dec*., 1930.—Light waves are too short and ordinary sound waves generally too long to permit experimental work on diffraction and scattering by a single small obstacle. An opportunity for such work, however, is presented in the case of ultrasonic waves. This paper describes an experimental investigation on the factors which determine the diffractive reflection and scattering of an ultrasonic wave train by plane circular opaque discs, and discusses the results. These are of special importance in the measurement of sound energy intensity by the torsion-pendulum method, for such measurements should always be corrected to allow for the effect of diffractive scattering of the energy by the measuring-pendulum vane. The correction factor will depend on the size and form of the pendula vanes employed and for circular vanes can be obtained directly from such curves as are shown in this paper as results of the investigation. AUTHORS.

1610. Damping of Sound Waves. Y. Rocard. *J. de Physique et le Radium*, 1. *pp*. 426–437, *Dec*., 1930.—Discusses the damping of sonorous or ultra-sonorous waves in a homogeneous gaseous medium. Goes over the work of Stokes, Rayleigh and Chapman on the modifications to be introduced into the fundamental hydrodynamical equations in order to allow for viscosity, for the influence of the radiation of heat, and for the thermal conductivity of air. Proceeds to consider the damping due to the reciprocal diffusion, in air, of its constituent elements. By this the condition of adiabatism is altered, and a new adiabatic equation is deduced. This new equation has a form $PV^{\gamma + i\beta\gamma} = \text{const.}$, where the imaginary, i, indicates a displacement of phase between the variations of pressure and of volume for the particular frequency used in determining the value of $\Delta\omega$. The value of $\Delta\gamma$ once obtained, it is easy to calculate the amount of damping due to this cause. The same method is used in a revision of the previous work of Stokes, Rayleigh and Chapman. The relative importance of the different causes of damping is discussed. A. D.

1611. Kirchhoff Constant, γ, and Its Variation with Temperature. P. Buss. *Ann. d. Physik*. 7. 5. *pp*. 601–623, *Dec*. 3, 1930.—The speed of sound in a tube (v) is related to that in the open air (v_f) by the Kirchhoff-Helmholtz formula $v = v_f(1 - \gamma/2r\sqrt{\pi n})$, where r is the radius of the tube and n the frequency of the waves. The speed was measured simultaneously in two tubes of different diameters held vertically in an electric furnace. The pressure changes in the resonance tubes were led to a telephone membrane, and the resulting current was amplified in a 4-valve circuit and measured by a dynamometer. Resonance curves were drawn and the wave-lengths in the two tubes determined. The Kirchhoff constant was expressed in terms of the difference in the wave-lengths. The constant γ is 0·84 at 19·7° C. It increases rapidly to 2·89 at 223° C., and thereafter has a slow increase to 3·30 at 674° C. The theoretical change is more regular and much smaller. G. E. A.

1612. Bactericidal Effects of H.F. Sound Waves. O. B. Williams and N. Gaines. *J. of Infectious Diseases*, 47. *pp*. 485–489, *Dec*., 1930.—Intense audible sound (frequency about 8800 cycles per second) was produced by the magnetostrictive vibration of a vertical nickel tube, the upper half of which was under water, the lower part being surrounded by two coils supplied with power from two 250-watt 3-electrode valves and being cooled by water trickling through from above. So intense was the vibration of the nickel tube that a mound or fountain of water 4 cm. high was produced above the upper end of the tube, which was closed with a plate of nickel. Suspensions of bacteria (*Escherichia coli*) contained in flasks were immersed in this fountain. At the beginning of an " irradiation " and at the end of each ten minutes, a sample was removed for quantitative plating in standard nutrient agar, the last sample being taken after an exposure to the sound of 60 minutes. A straight-line relationship was found between time of exposure and the logarithm of the number of survivors, the law being of the type $N = N_0\epsilon^{-kt}$. The lysis of red blood corpuscles by the audible sound was observed. AUTHORS.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

1613. Electricity by Bubbling. M. Lignana. *Accad. Sci. Torino, Atti,* 65. 12–14*a*. *pp*. 276–281, 1929–1930.—Air was caused to bubble through water and the charge developed at the bursting of a bubble was measured by a method of compensation. In the experiments the number of bubbles per min. varied between 100 and 150. From numerous experiments it is concluded that the mean value of the charge that a bubble of air of diameter 4·4 mm. gives up to the water after having bubbled through it is $0{\cdot}8 \times 10^{-14}$ coulomb. Various related phenomena are discussed and the conclusion is reached that when the electric charge is liberated by quick variation of the surface of separation between gas and liquid, the whole of the charge is not set free but only a part, and this is different in the various phenomena considered, as also the law of variation of the surface certainly differs in the various cases. J. J. S.

1614. Isothermic Metallic Piles. O. Scarpa. *Accad. d'Italia, Mem.* 1. (*Chim.*) 5. [28 *pp*.], 1930.—Discusses the mobility of ions in metals; diffusion in solid metals; the mobility of ions in solids; the mobility of ions in liquid metals; the e.m.f.s of contact between metals; the thermodynamic calculation of these forces; the e.m.f.s in closed metallic circuits; isothermic metallic piles; the limits of validity of the law of tensions; the limits of validity of the law of the intermediate metal. Concludes that the law of electrical tensions in metals (Volta's second law) is a limiting law only rigorously valid for ideal metals; that the same remark applies to the law of the intermediate metal; and that piles can be constructed entirely of metal and working under isothermic conditions. The experiments confirm the existence of free ions in liquid metals. The " metallic " character of a substance cannot be determined from the type of conductivity it possesses nor by considering whether it does or does not obey the law of tensions. A. D.

1615. Volta Effect. E. Dubois. *Ann. de Physique,* 14. *pp*. 627–725, *Dec.,* 1930.—Measurements of the Volta V-effect, made after heating a metal in a vacuum, and on re-cooling it, have led the author to the following conclusions. The metal shows at first, for heating at moderate temperatures, a variation V in the positive sense, called the positive variation. When heated at higher temperatures, there is then produced a variation of V in the inverse sense, called the negative variation. Also there occurs after each heating, in the positive sense, a variation of V with the time. The first two variations are due to the driving off of impurities, of which the two principal are probably oxygen and water vapour. Traces of alkaline salt can render a metal more electropositive. The variation with the time corresponds probably to a diminution of the density of the electronic emission of the pure metal. A description is given of the apparatus used, and the paper is amplified with numerous tables of figures of results and curves relative to the various metals used. T. C. H.

1616. Electrostatic Field of Two Forms of Condenser. W. Göhre. *Zeits. f. angew. Math. u. Mechanik,* 10. *pp.* 547–563, *Nov.–Dec.,* 1930.—The deviation of electrons in the electrostatic field of a condenser is composed of two parts, due to (1) the homogeneous part of the field and (2) the edges. Two types of condenser are considered, and the electrostatic field found by calculations regarding the lines of force and equipotential surfaces. The magnitude of the edge effect of each is found and compared with that due to a plane condenser employed by Helmholtz. R. S. R.

1617. Equipotential Lines in Electric Fields. P. Böning. *Zeits. f. techn. Physik,* 12. 1. *pp.* 50–53, 1931.—When electrodes of various shapes are placed on a glass plate sprinkled with powdered carbon (the sort used for medicinal purposes) and a sufficiently high potential difference is applied to the electrodes, a series of lines and bands is obtained in the powdered carbon, corresponding to the equipotential lines. An explanation of the effect is given. [See Abstract 410 (1928).] A. W.

1618. Theory of the Polarity Effect in the Passage of a Current through Solids. P. Böning. *Zeits. f. Physik,* 66. 9–10. *pp.* 581–597, 1930.—If certain layers of substance (half conductors) are inserted in an electric circuit with constant direct potential, various current strengths are produced according to the order of succession of the layers. The difference (polarity effect) can be so great that the current in one direction is vanishingly small, but in the other of large amount. Such a series of layers in an a.c. circuit may cause the current to flow in one direction only. The mechanism of this polarity effect is discussed and explained on the basis of the theory of ionic adsorption at internal boundary surfaces, which was put forward for the explanation of the general behaviour of insulators and half-conductors [see Abstract 2821 (1929)]. The theory is adapted not only to the main features of the phenomena but also to their details, and may give deeper insight into the nature of the passage of electricity. Some notes are given on the structure of detector crystals. J. J. S.

1619. Lightning Flashes. E. Mathias. *Comptes Rendus,* 191. *pp.* 1420–1422, *Dec.* 29, 1930.—The author states that many errors occur in the explanation of the action of lightning due to a confusion between what he terms the lightning flash and the fulminant matter. The former is the actual electric current, the latter is a gaseous explosive formed by the first lasting some thousandths or hundredths of a second depending on the type of lightning; in the case of spherical or globe lightning it may last for minutes. Various phenomena are discussed from this point of view and facts brought forward in support of the author's theory. F. S. B.

1620. Atmospheric Electric Potential Gradient at Bangalore. A. V. R. Telang. *Indian Journ. Phys.* 5. *pp.* 755–767, *Dec.* 31, 1930.—The atmospheric potential gradient was determined by means of a spiral coated with a radium salt placed at a distance from buildings and connected by a stretched copper wire with a quadrant electrometer, special care being taken as regards insulation during the rainy season. Hourly observations were recorded during 1927–28. Taking the results of 5 to 10 " quiet " days in each month, the records show a chief maximum between 5 and 6 hrs., and chief minimum between 19 and 20 hrs., with a smaller minimum between 15 and 16 hrs., and a somewhat indefinite maximum between 8 and 13 hrs. C. A. S.

1621. Twenty-five Years' Work on the Polar Aurora. C. Störmer. *Terr. Mag.* 35. *pp.* 193–208, *Dec.*, 1930.—Reference is made to the distribution, form, height and situation of the aurora and the determination of the two latter by simultaneous photography from two distant stations. The upper limits of the auroral rays can extend to 1000 km. and then be in sunlight. The sunlit auroral rays give a much fainter green aurora line than rays in the earth's shadow. From theoretical considerations, trajectories for corpuscular rays proceeding from the sun to the earth were calculated under simple assumptions and neglecting the electrostatic and electromagnetic action of sun and earth, the solar magnetic effect, gravitation and the pressure of light. The rays are confined to a toroidal space over the polar regions and produce the streamers and curtains observed. The question of wireless echoes is considered in its bearing on the composition of outer regions of the atmosphere. R. S. R.

1622. Earth-Current Observations at Huau-Cayo Magnetic Observatosy, 1927–1929. O. H. Gish and W. J. Rooney. *Terr. Mag.* 35. *pp.* 213–214, *Dec.*, 1930.—The apparatus and equipment used and the natural features concerned with the measurement of earth-current gradients at the Observatory maintained by the Carnegie Institute of Washington near Huau-Cayo, Peru, are described. A dual system of electrodes is installed and the potential differences are registered by a recording potentiometer. Although the region embraced by the measuring system is fairly flat, yet evidence is found which indicates that the general north-westerly direction of watercourse and mountain ridges here doubtless influences the direction of the electric currents. The character of the diurnal variation as derived from records for all complete days is exhibited by means of charts and tables, and the Fourier coefficients of the diurnal variation are given for the three-year means, for the means of individual years and for the three-year means grouped by months. The direction of the current is north-westward from 2h. 5m. to 12h. 5m., and south-eastward the remainder of the 24-hour period. The times of the daily maximum and minimum are constant, which is contrary to the findings at Berlin, Ebro and Watheroo. Disturbances (variations of relatively short and irregular period, with amplitudes considerably greater in the average than those of the diurnal variation) predominate during the daylight hours. W. C. S. P.

1623. Electrical and Magnetic State of the Interior of the Earth as Inferred from Terrestrial Magnetic Variations. S. Chapman and A. T. Price. *Roy. Soc., Phil. Trans.* 229. *pp.* 427–460, *Dec.* 31, 1930. —In a harmonic analysis of magnetic data the earth is considered to possess a permanent main field together with variable components, some periodic and some irregular. General formulæ are obtained for the electromagnetic and magnetic induction within a uniform conducting permeable sphere for (*a*) daily magnetic and (*b*) storm-time variations. Considerations from magnetic storm data indicate that the permeability cannot be appreciably above unity and may be less. It is shown that the idea of a uniform conducting sphere with an outer non-conducting layer is inconsistent with the diurnal periodic variation and the slower aperiodic variations in the later stages of the magnetic storm. The distribution of induced currents within the earth is calculated for the diurnal and storm-time variations in order to obtain the variation of conductivity with depth in the core. It is shown that storm-time variations in low latitudes are not due to varying primary currents in the auroral zones. An examination of Maris and Hulburt's theory of magnetic storms shows that it leads to wrong conclusions regarding the induced magnetic field in different phases of the storm. R. S. R.

1624. Summary of the Year's Work, Department of Terrestrial Magnetism, Carnegie Institution of Washington. J. A. Fleming. *Terr. Mag.* 35. *pp.* 231–236, *Dec.*, 1930.—The summary for the year is notable as recording the death of Ault, the disaster to the *Carnegie* and the retirement of Bauer. In research activities it is noted that the conductivity of the atmosphere was for the first time continuously recorded on a vessel. The experimental work on the earth-inductor method of measuring H has been most encouraging. Further, a practical design has been attained for a high-voltage vacuum tube to operate reliably at potentials up to two million volts, produced on a laboratory scale by Tesla coils. The very fast electrons from these tubes are equivalent to β-rays, and the tubes produce very penetrating X-rays equivalent to γ-rays. Much cooperative work has been done at different observatories on radio waves and terrestrial magnetism, and isomagnetic world charts for 1930 have been drawn. The year covered is from July 1, 1929, to June 30, 1930. G. E. A.

CURRENT ELECTRICITY, MAGNETISM AND ELECTRO-MAGNETISM.

1625. Effect of Cold Working on Density and Electrical Resistance of Metals. T. Uêda. *Tohoku Univ., Sci. Reports,* 19. *pp.* 473–498, *Dec.*, 1930. *In English.*—The change in the density and electrical resistance of Swedish steel, copper and brass, when stretched by a tensile testing machine, have been measured. The density of steels always decreased with an increasing tension; a discontinuous decrease occurred in low carbon steels, at the yielding point. The specific electric resistance always increased with the tension; at the yielding point, a discontinuous increase of the specific resistance in the case of low carbon steels and a decrease of resistance in that of medium or high carbon steels were observed. In the case of copper and brass, the decrease of density and the increase of specific electric resistance increased in magnitude with the tension; in this case, however, they did not show any discontinuity at the yielding point as in the case of carbon steels. AUTHOR.

1626. Variable Resistances and their Hydrodynamic Analogy. R. Auerbach. *Zeits. f. Physik,* 66. 7–8. *pp.* 499–512, 1930.—The analogy between the hydrodynamic behaviour of colloids dissolved with combination and the electric behaviour of variable resistances which do not obey Ohm's law is considered. Arrangements are given for the characterisation of variable resistances, and especially for the simple discrimination between the dependence on potential and the dependence on heating. Some peculiarities of variable resistances are dealt with such as their resistance-temperature hysteresis. It is shown that a hydrodynamic resistance characteristic falling with rising pressure is not only obtained with currents of colloid solutions through solid capillaries, but also conversely with currents of pure viscous liquids, as water, through capillary systems such as steeped gelatin powder. J. J. S.

1627. Electrical Resistance of Contacts between Solid Conductors. J. Frenkel. *Phys. Rev.* 36. *pp.* 1604–1618, *Dec.* 1, 1930.—A contact between two solid conducting bodies is visualised as a small

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gap between them. This gap can be described as a potential-hill over which electrons, according to the wave-mechanical theory, can pass even with insufficient kinetic energy. The general expression of the resulting current intensity as function of the potential difference is obtained and discussed for the case of two identical or different bodies in connection with the resistance of granular structures (thin metallic films) and the rectifying action of certain contacts. AUTHOR.

1628. Contact Rectification. Part I. Classification of Contact Rectifiers. M. Bergstein. *Am. Electrochem. Soc., Trans.* 57. *pp.* 419–426; *Disc.,* 426–434, 1930.—Preliminary to a general study of contact rectification, the known contact rectifiers are classified according to mechanical structure and the chemical nature of the more electronegative member. In contact rectifiers current flows generally from the more electronegative member to the more electropositive, but at lower a.c. voltages (as is indicated for CuS-Mg) the current flow may be in the reverse direction. An adequate theory of contact rectification must explain both these phenomena. AUTHOR.

1629. Contact Rectification. Part II. The Cupric Sulphide-Magnesium Junction. M. Bergstein, J. F. Rinke and C. M. Gutheil. *Phys. Rev.* 36. *pp.* 587–599, *Aug.* 1, 1930.—The commercial CuS-Mg junction consists of a disc of heat-treated, compressed CuS powder contacted under pressure with the suitably oxidised face of a Mg disc. This rectifier is of the non-integral class and of the sulphide group. Oscillographic evidence indicates the formation of a film which possesses relatively high resistance to current flow from the magnesium to the cupric disc, slow partial destruction of the film on continued current flow in the opposite (low resistance) direction and "reformation" of the film within 0·004 sec. when sufficient voltage is applied to send a current in the high-resistance direction. Similar evidence indicates that there is no battery or thermoelectric effect within the junction of sufficient magnitude to account for rectification and that film "formation" and "destruction" are consequently electrothermic rather than electrolytic in origin. The phenomenon of "reverse rectification" is described. It is related to the a.c. voltage across the junction. Preliminary results for the relationship between efficiency and operating temperature of a bridge-type unit are in qualitative agreement with the theories which require film formation. AUTHORS.

1630. Electrical Conductivity of Bismuth Alloys at Low Temperatures. J. C. McLennan, J. F. Allen and J. O. Wilhelm. *Roy. Soc. Canada, Trans.* 24. *Sect.* 3. *pp.* 25–32, *May,* 1930.—The authors have made determinations of the superconducting temperatures of alloys containing either bismuth or antimony. The effect of 58 % of Bi added to lead (42 %) gives an alloy having a superconducting point of 8·8° K., which is 1·6° above that of lead. A eutectic alloy of 17 % Sb and 83 % lead gives 6·6° K., which is slightly lower than that of lead. Rose's metal and Newton's metal give a superconducting point at 8·5° K., and the alloy Bi_5Tl_3 was found to give 6·4° K., which agrees with the value calculated by de Haas and Voogd from magnetic-resistance change considerations. The authors suggest that the results of these experiments imply the inadequacy of all the theories of electrical conduction in metals. [See also following Abstract.] W. C. S. P.

1631. Superconductivity of Alloys. J. C. McLennan, J. F. Allen, and J. O. Wilhelm. *Roy. Soc. Canada, Trans.* 24. *Sect.* 3. *pp.* 53–64, *May*, 1930.—Attention is drawn to the fact that the addition of Bi to a superconductor caused an elevation of the superconducting point, and that, in one case, antimony has the same property [see preceding Abstract]. The authors have now investigated the effect of adding other members of the Bi group to superconducting metals. All the binary alloys of the superconductors with members of this group show a pronounced elevation of the superconducting temperature, except in the case of Pb–Sb. Of the other alloys, Ag–Tl has shown a transition temperature higher than that of the superconductor alone. The resistance-temperature curve for the Pb–As alloy shows no discontinuity at the superconducting point, but runs down smoothly. This is the first time that a curve of this type has been observed. The superconducting points for alloys such as Pb–As–Bi, Pb–Bi–Sb and Pb–Bi–Sb–As were respectively 9° K., 8·9° K. and 9·0° K., much higher than any observed previously. The general conclusion is that most metals in alloys with superconductors do not affect the superconductivity appreciably. Some metals such as Au and Cu seriously disturb the superconductivity of some of the metals with which they are alloyed. With one exception the alloys of Bi, Sb, As and P have a higher transition temperature than those superconductors with which they are alloyed. W. C. S. P.

1632. Thermo Analysis of Metal Single Crystals and a New Thermoelectric Effect of Bismuth Crystals Grown in Magnetic Fields. A. Goetz and M. F. Hasler. *Phys. Rev.* 36. *pp.* 1752–1781, *Dec.* 15, 1930.—A method and apparatus are described whereby a fixed local temperature irregularity is applied at any point along a rod-shaped single crystal of bismuth or other metal, without subjecting the crystal to mechanical stresses. Any thermoelectric e.m.f. generated along the rod is measured with a galvanometer. The essence of the method consists in the use of a heated oil layer floating on water into which the crystal dips to a variable depth. A perfectly homogeneous crystal gives only a small residual e.m.f. due to inevitable asymmetry in the apparatus. A composite crystal, one half of which has been grown in a magnetic field, the other half in the absence of field, gives a more or less sharp peak in the thermoelectric e.m.f. as the oil layer moves across the junction. The variations in the magnitude of this effect as functions of the orientation of the crystal, the magnetic field strength, the temperature, the method of growth and presence of impurities were investigated. The results obtained are brought into relation with the diamagnetic anisotropy of bismuth. It appears possible to ascribe the effect to change in the secondary (mosaic) lattice of the Bi crystal. W. S. S.

1633. Measurement of Small E.M.F.s from Thermopiles. J. Guild. *Journ. Sci. Instruments*, 7. *pp.* 378–385, *Dec.*, 1930.—The paper describes an arrangement of circuits for the measurement of e.m.f.s ranging in value from a few microvolts up to those which can be measured conveniently on ordinary potentiometers. The e.m.f. is neutralised by a potential difference along a small resistance of fixed value. This potential difference is obtained by stepping down in a known ratio from a large variable p.d. in a branch circuit. Means are provided for neutralising any residual parasitic e.m.f. in the thermopile and galvanometer circuit. A feature of the system is that no elaborate apparatus is necessary, and the actual measurements are obtained with all the accuracy which is practicable in thermopile work on a direct-reading voltmeter or ammeter of good quality. AUTHOR.

1634. Corona Discharge in Hydrogen. J. H. Bruce. *Phil. Mag.* 10. *pp.* 476–480, *Sept.*, 1930.—The discharge was set up between a nickel wire and cylinder. The influence of gas pressure, purity and direction of discharge has been studied. The electric force X required to start a discharge (as in the case of other gases) is given by the expression $aX = f(ap)$, where a is the radius of the wire and p the pressure of hydrogen. The current in pure hydrogen is proportional to the applied potential. It is shown that the velocity W of the positive ions increases very rapidly as X/p increases. F. J. W.

1635. Dependence of Sparking Potential in Air on Frequency. H. Lassen. *Phys. Zeits.* 31. *pp.* 868–870, *Oct.* 1, 1930.—The sparking potential between spherical brass electrodes (diam. 1·1 cm.) in air is determined for undamped h.f. oscillations. One electrode is kept at earth potential while the potential of the other is gradually raised until a spark occurs. Potential is supplied by a h.f. valve-generator to which a tuned oscillatory circuit is coupled. The actual measurements are carried out with the latter circuit. The frequencies are measured by means of a calibrated wavemeter; those used in the present experiments were $1{\cdot}1 \times 10^5$, $3{\cdot}1 \times 10^5$, $8{\cdot}8 \times 10^5$, $2{\cdot}45 \times 10^6$. It is found that, in general, for each frequency the sparking potential agrees for small sparking distances with that obtained for low frequencies. From a certain critical sparking distance onwards, however, the sparking potential decreases. This critical sparking distance decreases as the frequency increases. Above the critical sparking distance the sparking potentials become lower as the frequencies increase. H. L. B.

1636. Optical Investigation of Sparking in Air at Atmospheric Pressure by Means of the Kerr Effect. L. v. Hámos. *Ann. d. Physik*, 7. 7. *pp.* 857–888, *Dec.* 29, 1930.—In the method here described the light from the spark-gap traversed a certain path and the potential surge a different path to the Kerr cell. The small time interval between the times required for traversing these two paths could be varied within certain limits, and thus the progress of the spark from its commencement could be investigated. In air at atmospheric pressure the progress of the spark was followed by varying the light path to the Kerr cell in steps of 10^{-9} sec. The results showed that the spark was completed within 10^{-8} sec. At the commencement of the discharge only a nitrogen band spectrum between 4000 and 5000 Å. was found. After about 2×10^{-9} sec. a luminous effect could be seen at the anode of which the spectrum corresponds with high space charge densities. The velocity of extension of this light towards the kathode was found to be about 5×10^7 cm./sec. A. W.

1637. Electric Breakdown of Gases and Space Charges. W. Rogowski. *Arch. f. Elektrot.* 24. *pp.* 679–690, *Dec.* 5, 1930.—A general discussion of the effect of space charges on the breakdown voltage of gases is given. With sufficiently strong space charges it is shown that the dark pre-discharge may be unstable. Subsequent sections deal with (*a*) the magnitude of the space charge for the commencement of instability, (*b*) space charges in relation to curvature of the ionisation curve, and (*c*) space charges and positive ions. [See also Abstracts 2641 (1930) and 188 (1927).] A. W.

1638. H.F. Electrodeless Discharge Characteristics. O. Stuhlman, Jr., and M. D. Whitaker. *Rev. Sci. Instruments*, 1. *pp*. 772–779, *Dec.*, 1930.—A spherical bulb containing mercury vapour at 25° C. and air at various pressures was excited to luminosity when placed in a fixed helical coil carrying damped h.f. currents developing a predominant electrostatic field. Range of frequency of excitation 1800 to 555 kc., of pressure 3 to 60 microns, of current 0·8 to 1·6 amperes. Visual intensity measured by a flicker photometer. No simple relations were found to exist between visual intensity of the electrodeless discharge and air pressure, current or frequency, but consistent irregularities were observed. The visual intensity was a maximum at a pressure of about 3 microns for all values of the exciting current, but the minimum measurable intensity shifted from higher to lower pressures as the exciting current was decreased. Periodic breaks were found to exist in curves showing visual intensity as a function of exciting current. Constant current and pressure maximum values of visual intensity were found for wave-lengths of 252, 358 and 490 m., corresponding to frequencies of n, $n + k$, and $n + 2k$. AUTHORS.

1639. Peculiar Types of Lichtenberg Figures. K. Umeda and M. Shoyama. *Tokyo B.D., Sci. Reports*, 1. *pp*. 63–66, *Dec*. 20, 1930. —The influence of the size and shape of the plate on the nature of the Lichtenberg figures has been studied. F. J. W.

1640. Method of Obtaining Hull-Debye-Scherrer Patterns of Kathode Rays. K. Matukawa and K. Shinohara. *Phys. Math. Soc., Japan, Proc.* 12. *pp*. 171–175, *July*, 1930. *In English.*—Thin films of metal sputtered from a kathode are used. The beam of electrons strikes the surface of the film and the diffraction is made visible photographically. F. J. W.

1641. Kathode Sputtering. C. H. Cartwright. *Rev. Sci. Instruments*, 1. *pp*. 758–763, *Dec.*, 1930.—Description of a piece of apparatus for the production of better mirrors, particularly of gold and platinum, by the sputtering process. The author has found that if the glass is first heated in the vacuum to 200° C. and then sputtered, a more perfect and more rugged mirror is obtained, but the heating does not affect the rate of deposition of gold and platinum. For glass plates less than 2 mm. thick, some copper filings were put on the electric heater and the glass laid on them. In the case of plates thicker than 5 mm. the mirror was floated in a low melting-point alloy of Bi, Sb and Sn contained in a metal dish on the heater. The temperature of the glass was measured with a constantan-copper thermocouple. If the glass is not heated before sputtering it becomes frosted soon after removing from the sputtering chamber. The necessity for maintaining the apparatus clean is emphasised. The two aluminium anodes provided are therefore outside the sputtering chamber. Films adhere equally well on glass and on quartz. W. C. S. P.

1642. Pressure and High-Velocity Vapour Jets at the Kathode of a Mercury Vacuum Arc. E. Kobel. *Phys. Rev.* 36. *pp*. 1636–1638, *Dec.* 1, 1930.—The amount of vaporisation of copper from the kathode of a copper arc measured by Tanberg [see Abstract 3525 (1930)], as well as the velocity of this vapour calculated from the force of reaction on the kathode, agree closely with the values obtained by another method from the kathode of a mercury arc. With a mercury arc and fixed kathode spot the mercury vaporisation is $0{\cdot}017 \times 10^{-3}$ gr./amp. sec. and the vapour velocity 16 to 43×10^5 cm./sec. AUTHOR.

1643. Influence of Traces of Hydrogen on the Spark Potential of Helium. A. Güntherschulze and F. Keller. *Zeits. f. Physik,* 66. 3–4. *pp.* 219–223, 1930.—With glow-light rectifiers, having highly degassed iron electrodes and helium filling, a rise in the spark potential from 182 to 320 volts has been observed over a period of time and established as being due to the disappearance of the last traces of hydrogen. This great activity of very small amounts of hydrogen is to be expected when it is realised that the hydrogen ion is a bare nucleus possessing four times the mean free path of all other positive ions. H. H. Ho.

1644. Glow Discharge in Rapidly Alternating Fields. Part II. F. Kirchner. *Ann. d. Physik,* 7. 7. *pp.* 798–804, *Dec.* 29, 1930.—A further experimental and theoretical paper on the phenomenon discussed previously by the author [see Abstract 2569 (1925)], that the glow discharge may be obtained in gases, even at very low pressures, and with voltages but little exceeding the ionisation potential of the gas, provided the potential is a rapidly alternating one. The origin of the "plasmoid" shining gas cloud described by R. W. Wood in these discharges is the main subject of discussion. It appears to carry a positive charge. J. H. A.

1645. Obstructed Arc Discharge. P. Bächtiger and M. Wehrli. *Helv. Phys. Acta,* 4. 1. *pp.* 31–48, 1931. *In German.*—The voltage is measured as a function of the electrode separation both in the glow discharge and the arc discharge, using tungsten hemispherical electrodes in nitrogen. All curves drawn for the pressures and currents investigated (24 to 500 mm. and 0·002 to 0·75 amp. respectively) pass through a minimum potential, corresponding to the kathode drop, according to Güntherschulze [see Abstract 3213 (1930)]. In this way the following results were obtained: (1) the law of Wehrli relating to the kathode drop was confirmed; (2) the voltage-pressure curve has a flat minimum at about 300 mm.; (3) a similar mechanism is present in the obstructed arc discharge to that found by Güntherschulze in the obstructed glow discharge. This mechanism is investigated. A. C. M.

1646. Comparison of Schweidler's Two Methods for Determining the Average Life of Small Ions in Air. C. O'Brolchain. *Gerlands Beitr. z. Geophys.* 29. 1. *pp.* 1–21, 1931. *In English.*—An outline is given of the theory suggested by Schweidler and also that of Nolan and others to determine β, the diminution constant of small ions in the presence of nuclei and large ions. In the measurements the apparatus employed was very similar to that used by Hess, and the results obtained by the two methods are tabulated. The ratio of the values of β found by the two methods varies considerably, and β_2/β_1 is always above 1 and the mean value about 2. The ratio does not depend on the absolute values of β_2 or β_1, nor on the rate of production of ions in the ionisation chamber. The mean value of the ratio of the numbers of positive and negative small ions per c.c. in the air of the ionisation chamber was found to be 1·20, where Nolan and de Sachy found for room air 1·11. [See Abstracts 1462 (1925) and 3226 (1930).] R. S. R.

1647. Dielectric Constant and Conductivity of Ionised Gases. J. V. Jonescu and C. Mihul. *Comptes Rendus,* 191. *pp.* 1436–1438, *Dec.* 29, 1930.—By allowing a stream of electrons, accelerated to a known extent, to move through gas in a tube with its axis parallel to the plates of a condenser, the change of capacity is measured by a resonance method, in which a second variable condenser is used as a compensator. It is found that for a given wave-length the conductivity and change of capacity vary proportionally to the intensity of the current of electrons. In the case of air, the change of capacity divided by λ^2 is negative for waves from 2 to 12 m. and then becomes positive. It is independent of the accelerating potential and of the magnitude of the current if it lies between 0 and 2 milliamperes. The conductance also varies, but up to 6 m. the value of conductance/λ^2 remains constant and then rapidly decreases to zero as the wave-length increases. H. L. B.

1648. Comparison of Molecular Ionising Potentials in an Alternating Electric Wind. W. M. Thornton. *Phil. Mag.* 10. *pp.* 1052–1063, *Dec.,* 1930.—With a strong alternating field the electric wind, even from an earthed pole, depends on the local gradient, not on the total voltage alone. If the earthed pole is a hot wire the wind is much increased, and it may even reduce a red-hot wire to blackness. The hot wire may be enclosed in an insulating vessel containing a gas, the pressure of which can be varied, and the temperature of the earthed pole can be determined by measuring its resistance. It is possible in this way to obtain values for the ionising potential of gases in terms of that of any one of them, since the cooling effect of the wind follows the same sequence as the reciprocals of the ionising potentials. The values obtained for the ionising potential are hydrogen, molecular, 42·4; oxygen, molecular, 6·9, atomic, 13·56; nitrogen, molecular, 11·5, atomic, 14·49; air, molecular, 11·50, identical with nitrogen and argon; methane, 11·3; ethane, 6·32; propane, 5; butane, 3·77; pentane, 3·49. When the paraffin ionising potentials, and that of hydrogen, are plotted against the number of carbon atoms in the molecule they are found to lie on a smooth curve, which is represented by a simple equation. The ionising potentials of a number of other gases have been determined. H. N. A.

1649. Cross-Section Measurements of Non-Inert Gas Molecules by Slow Electrons. E. Brüche, H. L. Bröse, and E. H. Saayman. *Ann. d. Physik,* 7. 5. *pp.* 579–600, *Dec.* 3, 1930.—Disagreement is expressed by Brüche with the conclusions and methods of representation given in a comprehensive paper by Bröse and Saayman [see Abstract 4091 (1930)]. He asserts (1) that their judgment is biassed in favour of those experimental results which most nearly approach the values obtained by Townsend's diffusion method, and (2) that the work of investigators using other methods has been misunderstood. He disputes the order of accuracy of 5 % claimed by Bröse and Saayman for Townsend's method, and quotes an early curve obtained by Townsend and Bailey for oxygen in support of his view. In answer to these criticisms by Brüche, the authors of the second paper of the present series point out that Brüche leaves untouched the main thesis of their original paper, namely, that the $Q - \sqrt{V}$ curves (which represent the variation of molecular cross-section with respect to electrons of decreasing velocity, $\sqrt{V}$) obtained by Ramsauer's method have a similar character to those obtained by Townsend's method. They refer to the tables of maxima and minima for the different gases given in their original paper. Also, when the values obtained by Townsend and Bailey for oxygen were first published these authors stated that negative ions were present in the gas and that the results could therefore be regarded as only provisional. With regard to objection (1), Bröse and Saayman refer to a long report on the subject by Brüche whch contains no mention of the work of Townsend and his collaborators and which gives the impression that the Ramsauer-Townsend effect was first discovered for the non-inert gases in 1925. The authors refer to the historical account given at the end of their original paper, in which it is shown that Townsend and Bailey first discovered the effect in 1921 for the ordinary gases. H. L. B.

1650. Energy Losses of Electrons in Carbon Monoxide and Carbon Dioxide. E. Rudberg. *Roy. Soc., Proc.* 130. *pp.* 182–196, *Dec.* 2, 1930.—Extends the work recently published on nitrogen [see Abstract 1368 (1931)] to the cases of CO and CO_2, using the same apparatus as before. In CO maxima were obtained at the following voltages: V_1 5·30, V_2 6·44, V_3 8·19, V_4 11·17, V_5 13·24, V_6 16·72, V_7 21·90, which are the average values for primary voltages ranging from 59·8 to 122·3 volts. The corresponding wave numbers are 42,963; 52,205; 66,391; 90,547; 107,328; 135,538; 177,528. V_1 and V_2 are due in some way to the apparatus, and not to CO. The maximum V_7 is attributed to electrons which have suffered two inelastic collisions, one with a loss V_3 and the other with a loss V_5. V_6 seems to be mainly due to single collisions, though two V_3 collisions would tend to produce a small maximum almost in the same position. V_3 is attributed to excitation to the first singlet state A from the normal X state; as to the vibrational level involved, it appears that the maximum occurs just in the middle of the group of vibrational levels, for which the closest distance of approach of two nuclei falls within the range of possible values for the nuclear separation, in the lowest vibrational state of the normal molecule. V_4, V_5 and V_6 are also discussed. Certain maxima have also been observed with CO_2, but the experiments are much less satisfactory with this gas. H. N. A.

1651. Applications of Electron Interferences for Structural Analysis. E. Rupp. *Phys. Zeits.* 31. *pp.* 1076–1078, *Dec.* 15, 1930. *Paper read before the Deut. Physikertag., Königsberg, Sept:,* 1930.—Deals with the interferences similar to those produced by X-rays, and which agree with them for high-velocity electrons, when they are treated as waves with wave-length given by the de Broglie equation $\lambda = \sqrt{150/V}$ Å., where V is the volt velocity of the electrons. There are, however, differences of intensity in the interferences as compared with those produced by X-rays, and the atomic form factor is in part determined by scattering of the electrons by the atomic nucleus, while X-rays are mainly scattered in the electron shell surrounding the nucleus. The experiments of Ponte, using thin foils, and those of G. P. Thomson, using grazing reflection, are mentioned. The author has experimented with slow electrons, V about 100 volts, instead of Thomson's 30 kV. The experiments must be made in a very high vacuum, and all metal parts must be glowed out; measurements of intensity have not been possible, but the diffraction maxima can be well reproduced. Gas adsorption on metals, surface layers on metals, and surface compounds have been investigated. Considerable difficulties arise in the explanation of the observed phenomena. H. N. A.

1652. New Method for Recording Electrons. P. H. Carr. *Rev. Sci. Instruments,* 1. *pp.* 711–743, *Dec.,* 1930.—A brief review is given of the use of photographic plates for the recording of electrons. Photographic plates are rendered more sensitive to the action of electrons by the application of a small amount of certain oils; but whether oiled or not, they are insensitive to the action of electrons when they strike the plate with a speed of less than 25 equivalent volts. This work indicates that the sensitising action of oil is largely due to kathodo-luminescence of the oil, and that the failure of the photographic plate to record low-speed electrons is due to the high electrical resistance of the photographic emulsion. Announcement is made of the discovery of the fact that metal surfaces are affected by electron bombardment in such a way that the bombarded regions react differently toward certain vapours than do the unbombarded regions. This effect has been observed even when the speed of the impinging electrons was only 12 equivalent volts. Experiments on silver and gold are presented in detail, and the practical use of the effect for electron recording demonstrated. Possible causes of the effect are also discussed. When the two methods for recording electrons are compared, it is found that the photographic method has the advantage of speed and ease of reproduction; while the metal method has the advantage of reliability, freedom from charging up, and insensitivity to light. Moreover, the metal method can be used for lower speed electrons than can the photographic method. AUTHOR.

1653. Theory of the Davis-Barnes Effect. J. L. Destouches. *Comptes Rendus,* 191. *pp.* 1438–1440, *Dec.* 29, 1930.—A formula given by Stueckelberg and Morse [see Abstract 4093 (1930)] is used to build up a theory of the Davis-Barnes effect [see Abstract 2579 (1930)]. The calculations give results which are in good agreement with the experimental observations of Davis and Barnes. H. L. B.

1654. Photoelectric Effect with Lead and Mercury at Low Temperature. J. C. McLennan, R. G. Hunter, and J. H. McLeod. *Roy. Soc. Canada, Trans.* 24, *Sect.* 3. *pp.* 3–23, *May,* 1930.—Up to the present nine metals and a number of alloys have been shown to possess the property of superconductivity at very low temperatures. It is now shown that the photoelectric effect of lead does not undergo any abrupt modification when the temperature of the lead is progressively lowered through its transition temperature, 7·2° K. Prior to 1922 it was thought that the photoelectric effect was independent of temperature. These experiments showed that there was a regular decrease in the magnitude of the saturation value of the photoelectric current as the temperature of the film of lead was lowered. Two types of highly evacuated photoelectric cells were used, one for temperatures down to 21° K. and the other for temperatures down to 4·2° K. The source of illumination (λ below 3,000 Å.) was a Cooper-Hewitt quartz mercury arc lamp. The photoelectric currents were measured on a Lindemann electrometer, using a null method. The work on mercury was finally abandoned as it was impossible to reproduce films of exactly the same thickness at temperatures of liquid air and of liquid hydrogen. This was necessary as it was found that the photoelectric currents were greater with a thin film than a thick one. W. C. S. P.

1655. Photoelectric Effect of Aluminium and of the Aluminium-Mercury Alloys. H. Gerding. *Zeits. f. phys. Chem.* 11. *Abt. B.* 1. *pp.* 1–37, *Dec.,* 1930.—Photoelectric measurements of aluminium and of its amalgams containing 0·06, 0·26 and 0·38 % mercury give the result that the photoelectric sensitiveness strongly increases by scraping *in vacuo* and varies with the wave-length of the light. Photoelectric fatigue is attended by oxygen adsorption. Increase of the work of emergence is caused by the negative contact potential between oxygen and metal. Maximum values of sensitiveness for the scraped metals *in vacuo* are greater for amalgams with 0·38 and 0·26 % mercury than for 0·06 % or for pure aluminium. The amalgams and aluminium exhibit metallic differences. H. H. Ho.

1656. Observed Temperature Dependence of the Stop-Layer Photo-Effect with Copper-Cuprous Oxide Cells. H. Teichmann. *Zeits. f. Physik*, 65. 9–10. *pp.* 709–713, 1930.—Measurements are now recorded with experimental details which show that the stop-layer photo-effect possesses a negative temperature coefficient. H. H. Ho.

1657. Photoelectric Emission from Thin Films of Cæsium. L. R. Koller. *Phys. Rev.* 36. *pp.* 1639–1647, *Dec.* 1, 1930.—The photoelectric properties and the methods of preparing thin films of cæsium are described. These are divided into two classes: (1) those where a thin film of Cs is adsorbed on a thin layer of oxygen, and (2) those where a thin film of Cs is adsorbed on a layer of suboxides of Cs. Surfaces of the latter type were prepared by coating a kathode with metallic cæsium and then admitting oxygen in very small quantities. The photoelectric current was observed simultaneously. The measurements show that the most sensitive surfaces are obtained when the cæsium has taken up sufficient oxygen to form a suboxide rather than the normal oxide Cs_2O. These films owe their properties to the arrangement of the molecules very near the surface.

AUTHOR.

1658. Quantum Mechanics of Photoelectric Processes. M. Stobbe. *Ann. d. Physik*, 7. 6. *pp.* 661–715, *Dec.* 9, 1930.—A mathematical treatment of the emission of continuous spectra, the absolute evaluation of the photoelectric effect, the recombination of free atomic nuclei with electrons, and the photoelectric absorption coefficients for X-rays.

G. E. A.

1659. Units Used to Express the Wave-lengths of Electromagnetic Waves. H. D. Hubbard. *Bureau of Standards, Misc. Pub.* 117. [4 *pp.*], 1930.—The closing up of the gaps in the wave gamut of electromagnetic radiations makes it opportune to systematise the units and unit usages to cover the entire range. A well-selected series of units connected with the c. g. s. unit by the " powers-of-10 notation " will facilitate computation and conversion, and aid in visualising, comparing and correlating widely differing wave magnitudes. This paper aims to give the best existing usages including the trend towards the units which have a multiple or submultiple relation of 1000 connected by the powers of 10 equivalents.

AUTHOR.

1660. Hypothetical Existence of Resonators of Hertzian Frequency in Water. P. Girard and P. Abadie. *Comptes Rendus*, 191. *pp.* 1300–1302, *Dec.* 22, 1930.—The authors have employed the first method of Drude, determining by means of Lecher wires the wave-length in air and in the liquid studied. Results have been obtained with distilled water, and with a 0·15 *N* solution of Na_2SiO_3. The extreme difference in index of refraction found by Weichmann and Frankenberger is about 3·5 times as great as that found by the authors for the same wave-length region. The latter are of the same order of magnitude as the experimental errors. No sign was found of the bands of dispersion reported by Weichmann and Frankenberger in the region of wave-length 50–60 cm., even with the Na_2SiO_3 solution. H. N. A.

1661. Standing Electrical Waves in Wires. R. King. *Ann. d. Physik*, 7. 7. *pp.* 805–832, *Dec.* 29, 1930.—A complete and comprehensive account of certain not generally known effects observed in parallel systems of wires, together with an exact measuring method and a theoretical treatment of the subject which explains the results obtained. The author describes the resonance indicator and the oscillator which he uses. The system arranged for loose coupling with a bridge between the parallel wires is dealt with and the author shows that one side of the bridge forms a primary circuit, and the other the corresponding secondary. The effects in these circuits are interdependent, the deflections of the resonance indicator in both of them depending on whether the *two* circuits are tuned to the oscillator or not. He finally shows how the frequency can be affected by the coupling, and how there may be jumps in wave-length and frequency when the length of the secondary circuit is altered. H. N. A.

1662. Potential of a Magnetic Shell with Circular Edge. B. Pelini. *Accad. Lincei, Atti*, 12. *pp.* 216–222, *Sept.*, 1930.—Gives a table correct to within 1 in 10,000 of the solid angle under which a circle of unit radius is seen at a distance r and at colatitude ϕ from the plane of the circle. E. E. F. d'A.

1663. Development of New Theory of Magnetism. K. Honda. *Tohoku Univ., Sci. Reports*, 19. 6. *pp.* 745–759, *Dec.*, 1930. *Report No.* 259 *of the Research Inst. for Iron, Steel and other Metals*.—In this paper a small alteration in the author's theory of magnetism published two years ago [see Abstract 1984 (1928)] is described. This form of the theory explains the gyromagnetic effect as well as the magnetic deflection of atomic rays in a strong field. The usual explanation of the latter phenomenon by quantum theory is not consistent with the dynamical theory of electrons. It is also shown that Weiss's and Heisenberg's theories of ferromagnetism are not in good agreement with experimental facts. AUTHOR.

1664. Magnetic Moments of Atomic Nuclei. E. Fermi. *Accad. d'Italia, Mem.* 1. (*Fis.*) 1. [12 *pp.*], 1930.—The hyperfine structure of spectra is deduced from an interaction between the movement of the atomic electrons and the intrinsic magnetic moment of the nucleus. From the experimental data of the structure of the spectrum are deduced the magnetic moments of the nuclei of sodium, rubidium and cæsium. A. D.

1665. Change of the Magnetic Moment of NO with Temperature. E. C. Wiersma, W. J. de Haas and W. H. Capel. *K. Akad. Amsterdam, Proc.* 33. 10. *pp.* 1119–1124, 1930.—Van Vleck has shown that the magnetic moment of NO would probably change with temperature and calculated the values over a wide range. The magnetic moment of the NO molecules is now measured experimentally, a full description of the apparatus employed being given. The results show, in general, a very good agreement with the values of van Vleck. For the temperature of 238·40° the authors assume the value of van Vleck to be correct, and the other susceptibilities are calculated from this datum. The mean of the values for three different fields was taken, and from the results the value of the magnetic moment of a molecule of NO in relationship to the Bohr magneton was found. The results are given in a table embodying the values from 292·1° K. to 112·77° K. At very low temperatures slight systematic differences exist, reaching about 8 pro mille at most, otherwise the experimental measurements give points lying on the theoretical curve showing the relationship of temperature to the magnetic moment in Bohr magnetons. An accuracy of 3·5 % is obtained for the value of the moments. S. G. B.

1666. Diamagnetism According to Thomas-Fermi Statistics. T. Takéuchi. *Phys. Math. Soc. Japan, Proc.* 12. *pp.* 300–302, *Dec.*, 1930. *In German.*—From the approximation of Thomas and Fermi for the electron distribution in a heavy neutral atom, the equation is derived: $\chi_d a Z^{-\frac{1}{3}} =$ constant, where $-\chi_d$ is the diamagnetic susceptibility of a metal crystal, a the atomic volume, and Z the atomic number. The product is evaluated for the elements Al, Cr, Cu, Ag, Au and Pb, and the results agree as to order of magnitude. G. E. A.

1667. Dependence of the Susceptibility of Diamagnetic Metals upon the Field. W. J. de Haas and P. M. van Alphen. *K. Akad. Amsterdam, Proc.* 33. 10. *pp.* 1106–1118, 1930.—Three factors must be regarded in the diamagnetism of metals: (1) the diamagnetism of the electrons bound within the atom; (2) the influence of the so-called free electrons on the whole diamagnetic effect; (3) the influence on the bindings of the crystal lattice. Lorentz showed that the free electrons do not contribute to the diamagnetism and in the classical calculation the conducting electron has been assumed absolutely free; a hypothesis which is invalid. The great susceptibilities of Bi, Sb, etc., make it probable that the conducting electrons contribute to the diamagnetism. The author suggests that where the binding of the conducting electron is strong great diamagnetism may be expected, so that during some time the conducting electron must be strongly under the influence of two neighbouring atoms. The crystal lattice has a great influence on the phenomena, *e.g.* white tin is paramagnetic and grey tin is diamagnetic. For high diamagnetism the influence of the crystal lattice closely depends upon whether the free electrons are bound more or less loosely. In the present work lead, tin and bismuth were investigated, the last at some length in the form of single crystals. By means of a microbalance the substance under test is weighed under the prescribed conditions both with and without the magnetic field. From the phenomena exhibited it is possible to assess with great certainty as to the purity of the specimen. A strong diamagnetism is always a sign of purity, both ferromagnetic and paramagnetic substances exhibiting the reverse signs. The susceptibility of bismuth at low temperatures, *i.e.* of liquid hydrogen, is found to be a periodic function of the field. The susceptibility in directions perpendicular to the principal axes is a complicated function of the field and the angle between the binary axes and the field. Finally it was shown that the bismuth atoms close to each other are subjected to their mutual influences. Experimental details are given. S. G. B.

1668. Magnetic Susceptibility of Gases. Part II. Temperature Dependence. F. Bitter. *Phys. Rev.* 36. *pp.* 1648–1653, *Dec.* 1, 1930.—The susceptibilities of CO_2, N_2 and H_2 are measured at room temperature and at liquid air temperature using O_2 as a standard. The results for molecular susceptibility × 10^6 are:

	298° K.	88° K.
CO_2	$-24 \cdot 2$	—
N_2	$-14 \cdot 8$	$-14 \cdot 2$
H_2	$-5 \cdot 8$	$-3 \cdot 3$

The relative values at room temperature are in fair agreement with most previous observations, but the absolute values are more diamagnetic than any previously recorded. The low temperature observation on N_2 can be interpreted as meaning that if a permanent moment is present, it is less than 1/25 of a Bohr magneton. The large change observed in H_2 is entirely unexpected, and the observations should be repeated. [See also Abstract 3558 (1930).] AUTHOR.

1669. Magnetic Susceptibility of Gases. H. Buchner. *Ann. d. Physik*, 7. 6. *pp.* 716–730, *Dec.* 9, 1930.—A modification of Gouy's method was employed to measure the susceptibility of CO_2. The result obtained, $K = -8 \cdot 6 \pm 0 \cdot 4 . 10^{-10}$, was in good agreement with previous determinations. The susceptibility is proportional to the pressure, also when small quantities of O_2 were added. It is supposed that the Glaser anomaly with regard to pressure is due to the presence of water vapour, and experimental evidence is in favour of this supposition. [See also Abstract 2281 (1929).] G. E. A.

1670. Susceptibility of Cupric Sulphate Pentahydrate at Low Temperatures; Magneton Numbers in the Iron Group. W. J. de Haas and C. J. Gorter. *K. Akad. Amsterdam, Proc.* 33. 10. *pp.* 1101–1105, 1930.—The description of work continued from a previous paper [see Abstract 1384 (1931)] on the measurement of the susceptibilities of a series of compounds, the magnetism of which may be ascribed to one magnetic electron per metallic ion, at low temperatures. The susceptibilities of cupric sulphate pentahydrate, the anhydrous sulphate and chloride have been determined. In the case of $CuSO_4 . 5H_2O$ the susceptibility was measured from 290° K to 14·29° K. The law of Curie-Weiss is followed with the value of $\theta = -0 \cdot 70°$ and $p = 9 \cdot 51$ W.M. The theory of Hund, which gives such good results for the rare earths, is known to be in disagreement with the magneton numbers found for the Fe group. The Bose-Stoner theory has been developed to explain this, and in the present work is developed in still more detail. For the first half of the Fe group the Bose-Stoner theory agrees well with experiment; whilst for the second half the agreement is not so good. In the second half of the Fe group the energy splitting by the Stark effect or by resonance may not be considered as large compared with the multiplet decomposition, the latter amounting to more than 1000 cm.$^{-1}$. This may imply that the lowest level does not give exactly the magneton number to be expected for perfect uncoupling. The deviation from this expected value will be determined by the degree of this uncoupling. When the latter differs for different compounds of the same ion the magneton number will also vary. The known variability of the magneton number is found for Fe^{+++} just where deviation from the Bose-Stoner values occurs. S. G. B.

1671. Magnetic Isotropy of a Paramagnetic Alum. C. G. Montgomery. *Phys. Rev.* 36. *pp.* 1661–1662, *Dec.* 1, 1930.—It is shown that cubic crystals of potassium chromium alum are magnetically isotropic.
AUTHOR.

1672. Paramagnetism Independent of the Temperature. Existence of Electronic Isomers in Polyatomic Ions. S. Freed and C. Kasper. *Am. Chem. Soc., J.* 52. *pp.* 4671–4679, *Dec.*, 1930.—In accordance with Curie's law, paramagnetic susceptibility is stated to be inversely proportional to the absolute temperature. Many substances, however, display a somewhat more complicated behaviour and require an arbitrary constant to describe their deviation from Curie's Law. A number of substances have been found to have susceptibility quite independent of temperature. One type of substance exhibiting constant paramagnetism has also been investigated. It consists of a molecular ion in which a metallic constituent is surrounded with just the number of electrons which suggest a very balanced and symmetrical arrangement. The object of the present work is to observe by precise measurements to what degree the paramagnetism of ions is independent of the temperature and to correlate their magnetism with the results of quantum mechanics. The method due to Freed for measuring susceptibilities at low temperatures was adopted, incorporating the use of a more sensitive microbalance. Experimental details are fully given. The degree of dependence of the susceptibilities of UO_2^{++}, WO_4^- and $Cr_2O_7^-$ on the temperature has been accurately studied from room temperature to that of liquid air. The susceptibility of UO_2^{++} was found to decrease slightly and uniformly as the temperature was reduced. Ishiwara points out that $M_nO_4^-$ probably behaves similarly. The other two, mentioned above, show no variation in their susceptibilities within the experimental error. The properties of these ions are taken as being of such a nature as to permit the application of modern magnetic theories. Their constant paramagnetism is related to the results of van Vleck derived from quantum mechanics, and in consequence the existence of electronic isomers in those molecular (polyatomic) ions is recognised. Thus, constant paramagnetism is regarded as a general phenomenon associated with the existence of activated electronic energy levels in molecules or their ions in the solid state and in solution as well as in the gaseous state. S. G. B.

1673. Duplication of Nickel at the Curie Points. R. Forrer and A. Hoffmann. *Comptes Rendus*, 191. *pp.* 1046–1049, *Dec.* 1, 1930.—It is known that the paramagnetic Curie point, θ_p, determined by Weiss' law does not coincide with the ferromagnetic Curie point θ_f, with regard to the disappearance of the remanent magnetism. The difference $(\theta_p - \theta_f)$ is of the order of 20 degrees. The authors have shown that the coercive field does not disappear at the point θ_f, and that the feeble curvature of the curve expressing the coercive field as a function of the temperature permits extrapolation towards the temperature axis, and thus gives a Curie point of the coercive field, θ_H. The relationship of the differences $(\theta_p - \theta_f)$ and $(\theta_H - \theta_f)$ permits a hypothesis for the coincidence of θ_H and θ_p. Experiment confirms the existence of the difference $(\theta_H - \theta_f)$, and it is now examined in its relationship to mechanical and thermal factors. In the case of Ni the resulting phenomena are explained by the authors by the postulation of the existence of two ferromagnetic substances in the metal with different ferromagnetic Curie points, namely θ_{f_1} and θ_{f_2}. The difference between these two points is about 6° according to the type of Ni examined. The paper embraces a full discussion of the points relative to the above statements. S. G. B.

1674. Direction of Magnetisation of Single Ferromagnetic Crystals. F. C. Powell. *Roy. Soc., Proc.* 130. *pp.* 167–181, *Dec.* 2, 1930.—Suggests that the facts may be explained by taking into account the magnetic interaction between each electron and the atom to which it belongs; such interaction is known to give rise to multiplet separation. Supposes that this interaction can be represented by a field G, fixed in the crystal, the crystalline field. Assumes that G can be in a number of possible directions, which bear simple relations to the crystal structure. The theory applies strictly only to zero temperature, but may be used as an approximation for ordinary room temperatures. By this means the deviations between the directions of the applied field and of the magnetisation can be explained, both in cubic and non-cubic crystals, and the required magnitude of G is in agreement with that deduced from spectroscopic data. There is no reason to suppose that the crystalline field exists only in ferromagnetic crystals, and it may prove possible to develop a theory of paramagnetic crystals at low temperatures. Special attention is given to the cases of iron (body-centred cubic structure), nickel (face-centred cubic) and cobalt (hexagonal close-packed). H. N. A.

1675. Use of the Laws of Ferromagnetic Anisotropy for the Calculation of the Characteristics of Polycrystalline Iron. N. S. Akulov. *Zeits. f. Physik*, 66. 7–8. *pp.* 533–542, 1930.—A formula is deduced, from which, by the substitution of experimentally obtained values, for individual crystals, the work of magnetisation, the magnetostriction and the alteration of the electrical resistance by magnetisation, can all be estimated for polycrystalline ferromagnetic materials. In the case of saturation the formula is strongly valid, but for other selected values of the intensity it is sometimes valid and in other cases only approximate. The analogous formula for the calculation of the magnetisation curve is also given. The particular instances of perminvar and similar materials are treated. It is shown that if the value of X is known for two different crystallographic directions, then the value of $\overline{X}$ for the polycrystalline medium can be found from the expression: $\overline{X} = \frac{1}{5}(2X_{100} + 3X_{111})$. Compared with observed values at saturation for the change in electrical resistance this is in good agreement, giving a value 0·244 as against Webster's experimental result of 0·25. S. G. B.

1676. Magnetic Properties of Pt–Co and Pd–Co Alloys. F. W. Constant. *Phys. Rev.* 36. *pp.* 1654–1660, *Dec.* 1, 1930.—If ferromagnetism is due to interaction between the electrons of neighbouring ferromagnetic atoms, the effect on the magnetic properties of gradually separating these atoms is of interest. For this reason alloys of the Pt-Co and Pd-Co series were investigated. As the alloys were solid solutions, for small cobalt content the cobalt atoms could be regarded as partly isolated by the non-ferromagnetic atoms. The magnetic properties of these alloys showed a lowering of the Curie point and a decrease in the remanent magnetisation and coercive force with decrease in the percentage of cobalt in accord with theory. An observed increase in the magnetisation per cobalt atom is discussed along with recent theories of ferromagnetism. AUTHOR.

1677. Penetration of Electromagnetic Waves into Saturated Iron. F. Ollendorff. *Zeits. f. techn. Physik,* 12. 1. *pp.* 39–50, 1931.—A theoretical investigation in which the variation of permeability is taken into account. From the solution, the magnetisation curve is reconstructed and found to agree with one drawn from the known empirical laws. In the region of penetration of the waves into unsaturated iron, the permeability is greater than that at the edge. In the edge region both field and induction undergo rapid diminution. Thereby losses arise in addition to those which occur in unsaturated iron which are substantially independent of the frequency. Saturation of the iron has practically no effect on the increase in losses due to hysteresis. Comparison between theory and experiment gives good agreement. G. E. A.

1678. Thermal Effects during Hysteresis Cycles. A. Guilbert. *Comptes Rendus,* 191. *pp.* 1309–1311, *Dec.* 22, 1930. *Soc. Franç. Élect., Bull.* 1. *pp.* 175–202, *Feb.,* 1931.—Measurements were made of the heat adsorbed or emitted by a specimen of cobalt steel during hysteresis cycles of maximum inductions 15,420 and 18,470 gauss respectively. The results are represented by plotting $H_r = H - 4\pi\frac{dQ}{dB}$ against B, where H is the exciting field, B the induction and dQ the heat developed when the induction changes by dB. The (BH_r) curves corresponding to increasing and decreasing applied field, nearly coincide, and it is shown that they would coincide in the absence of thermomagnetic effect. In that case the hysteresis phenomenon in iron is explained if the iron possesses a reversible isothermal magnetisation curve and the heat evolved in change of magnetic state is due to the apparent displacement of this magnetisation curve owing to the existence of an interior field $H_i = -4\pi\frac{dQ}{dB}$. The (BH_r) curve would be the magnetisation curve of molecules freed from all mechanical interaction. W. S. S.

1679. Longitudinal Thermomagnetic Potential Effect. J. Zahradniček. *Zeits. f. Physik,* 66. 5–6. *pp.* 425–430, 1930.—In a metal rod which is traversed by a flow of heat there occurs in a transverse magnetic field a change of the potential fall in the direction of the flow. For this longitudinal thermomagnetic potential effect a new method of measurement is described. The metal to be examined is in the form of a wire, connected at its ends to a galvanometer, so arranged between the pole pieces of an electromagnet and led through the heating baths that the whole temperature fall in the wire occurs in the magnetic field. Alternatively the wire is drawn either only once or n times in the magnetic field and through the baths—multiplication method. Some measurements for one turn and a coil of 16 turns of iron wire are given. The resulting potential difference is measured as function of the external field strength H and the induction B. J. J. S.

1680. Representation of Processes in the Electromagnetic Field by Lines of Force. G. Siemens. *Zeits. f. Physik,* 66. 5–6. *pp.* 396–413, 1930.—A discussion of the electromagnetic field, and the advantage to be obtained by representing processes which are non-static by means of lines of force. It has been customary to regard the electromagnetic field of a steady current as a statical one. Representation of the process by the

motion of lines of force discloses the fact that the field is pseudostatic, and the Poynting theorem can be applied without omitting a certain limitation.
G. E. A.

1681. Schmidt Magnetic Apparatus. A. Belluigi. *Pont. Accad. Sci., N. Lincei, Atti,* 83. *pp.* 70–75, *Dec.* 29, 1929.—Temperature correction to readings of the Schmidt apparatus are important, especially for use in geological field work. The determination of the temperature coefficient and its variation under temperature changes is described. W. A. R.

1682. Values and Inter-Relationships of c, e, h, M_p, m_0, G and R. W. N. Bond. *Phil. Mag.* 10. *pp.* 994–1003, *Dec.*, 1930.—A critical discussion of the most probable value of c (velocity of light), e (electronic charge), h (Planck's Constant), M_p (mass of proton), m_0 (mass of electron) and G (gravitational constant), and such relationships as hc/e^2, M_p/m_0, hc/M_p^2G. Evidence is given that the Eddington value $hc/2\pi e^2 = 137$ is probably correct, and assuming this relationship, a new value of e is obtained, from which values of h, e/m, G, etc., may be redetermined. The chief constants found are $e = (4{\cdot}779_7 \pm 0{\cdot}0017)10^{-10}$, $h = (6{\cdot}559_6 \pm 0{\cdot}0046)10^{-27}$, $e/m = (1{\cdot}7688_2 \pm 0{\cdot}0006_3)10^{-7}$ abs. e.m.u and $G = (6{\cdot}635 \pm 0{\cdot}001)10^{-8}$. G. E. B.

1683. Specific Charge of the Electron. F. Kirchner. *Phys. Zeits.* 31. *pp.* 1073–1075, *Dec.* 15, 1930. *Paper read before the Deut. Physikertag, Königsberg, Sept.*, 1930.—In the previous measurement made by the author the frequency of the electrical vibrations employed was measured by means of a system of Lecher wires, but this gave no continuous control of the vibrations. In the present experiments a Giebe and Scheibe piezoquartz resonator, calibrated by the Reichsanstalt, was employed for the control and measurement of the frequency, and, except for the unknown contact potential between the hot wire filament and the observation space, the sum of the probable instrumental errors was certainly not more than 0·2 per thousand. Assigning to this error its maximum possible value of about 1·5 volts, with a correction of 0·1 per thousand for the fact that the paths of the electrons are not exactly straight, the final value is arrived at $e/m_0 = 1{\cdot}7602 \pm 0{\cdot}0025$ e.m.u. This differs considerably from the most accurate value measured with kathode rays previously, which was $1{\cdot}7689 \pm 0{\cdot}002$ obtained by F. Wolf, but agrees very well with that obtained by Houston spectroscopically, from the shift towards the violet of the He lines, as compared with the corresponding H lines. This value was 1·7606. The new measurement by Perry and Chaffee is mentioned.
H. N. A.

1684. Value of e/m by Deflection Experiments. G. E. Uhlenbeck and L. A. Young. *Phys. Rev.* 36. *pp.* 1721–1727, *Dec.* 15, 1930.—To clarify the discussion as to whether or not a quantum-mechanical treatment of the motion of electrons in magnetic fields will lead to a formula for e/m, differing from that obtained by classical electrodynamics the following problem was solved. A uniform magnetic field in the z-direction exists in the half-space $x>0$. A plane monochromatic de Broglie wave, travelling in the positive x-direction representing electrons of arbitrary energy, impinges normally on the plane $x = 0$. Solutions of the wave equation were found fulfilling appropriate boundary conditions at the plane $x = 0$. Currents are calculated quantum-mechanically and

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compared with the corresponding classical expressions. It was found that for electrons possessing energies of the order of magnitude used in deflection experiments, no *observable* deviations from classical results are predicted. Another quantum mechanical effect is diffraction at slits. Simple approximate calculations show that this effect can produce a fractional error in e/m of the order of the de Broglie wave-length divided by the slit width. These results are opposite to the conclusions reached by Page [see Abstract 270 (1931)]. The authors remark that he solved a problem of " stationary states " which does not represent the actual experiments. AUTHORS.

1685. Relativistic Wave Mechanics of Electrons Deflected by a Magnetic Field. M. S. Plesset. *Phys. Rev.* 36. *pp.* 1728–1731, *Dec.* 15, 1930.—It is shown that the relativistic wave equation for electrons in a uniform magnetic field leads to the same wave function as that already deduced by Page [see Abstract 270 (1931)] from the non-relativistic equation. As in the latter case the motion at right angles to the field is quantised. An expression is found for the current density from the relativistic wave equation. The relativistic expression differs from the non-relativistic only by a constant factor which does not affect the calculation of the mean radii of curvature of the electron current. Hence, for the relativistic case, as for the non-relativistic, the mean radius of curvature is less than that expected on the classical theory. It follows that the classical relativistic relation between e/m and the mean radius of curvature upon deflection gives a value of e/m which is too large. AUTHOR.

1686. Graphical Calculation of the Magnitudes Attached to an Electron in Motion. J. Fournier. *Comptes Rendus*, 191. *pp.* 1302–1304, *Dec.* 22, 1930.—Gives a simple diagram which shows graphically the relation between the Lorentz contraction factor; the proper time factor in the Lorentz transformation which is used in the calculation of the mass; the factor involved in the calculation of the potential of emission of the electron, of its energy and of the corresponding frequency of the electromagnetic vibration; the factor involved in the calculation of the product $H\rho$ (ρ is the radius expressed in cm. of the circle described by the electron in a magnetic field of H gauss); finally the factor involved in the calculation of the de Broglie wave-length associated with the electron in wave mechanics. H. N. A.

APPARATUS AND INSTRUMENTS.

1687. Production of Extremely High Voltages. M. A. Tuve. *Phys. Rev.* 36. *pp.* 1576–1578, *Nov.* 15, 1930.—Ordinary methods for the production of high voltages for application to vacuum-tubes are satisfactory up to several million volts, but are subject to definite limitation due to corona or sparkover from the high-voltage terminal to earth. A system of successive Faraday cages, with the outermost cage earthed, is not so limited. An impulse-method for the production of extremely high voltages using such a system of Faraday cages is described. A system of $(2n + 2)$ cages gives an impulse-voltage slightly less than nV on the innermost cage. AUTHOR.

1688. Braun Tube as Light Source. W. Rogowski and E. Rühlemann. *Arch. f. Elektrot.* 24. *pp.* 691–692, *Dec.* 5, 1930.—Using a kathode-ray oscillograph with a potential of 55 kV between the anode and kathode it was found that when the main concentration of the beam was dispensed with and only the pre-concentration coil employed a brilliant disc of light about 2 cm. diameter was obtained on the zinc sulphide screen. The light from this spot on the screen was very intense and showed a continuous spectrum extending from the violet to the red. [See also Abstracts 851 (1926) and 181 (1928).] A. W.

1689. Resistance Coil for Measurements at Very High Voltages. P. de la Gorce. *Comptes Rendus,* 122. *pp.* 1297–1299, *Dec.* 22, 1930.—In addition to the principal resistance (measuring resistance) an auxiliary resistance (guard resistance) is employed in parallel with it, and surrounding it, so that it acts as a screen, and tends to eliminate the effect of the capacity of the principal resistance with respect to the earth. The guard resistance has the same number of bobbins as the main resistance, like it has an even number of bobbins, successive bobbins being wound in opposite directions. The bobbins of both resistances form two coaxial cylinders. The two resistances have a common h.t. terminal; the other end is in both cases connected to earth, directly in the case of the guard resistance, through the measuring apparatus in that of the measuring resistance. In the space between the two coaxial cylinders there is no radial field, since the potentials are the same at corresponding points on the outer surface of the main resistance, and the inner surface of the guard resistance. H. N. A.

1690. Shakespear Hot-wire Micrometer. E. B. Moss. *Journ. Sci. Instruments,* 7. *pp.* 393–396, *Dec.,* 1930.—The micrometer is a Wheatstone bridge system in which the arms are spirals of wire having a temperature coefficient. The temperature to which the arms are raised by a current through the bridge depends partly on the spacing of the turns, and this property enables it to be used as a measuring device. Commercial applications of the instrument are mentioned. AUTHOR.

1691. Limits to the Sensitiveness of the Vacuum Duanten Electrometer. W. Eggers. *Ann. d. Physik,* 7. 7. *pp.* 833–856, *Dec.* 29, 1930.—Describes a form of moving system which weighs only 2·5 mg., while that supplied by the makers weighed about 5 mg. Measurements of the damping showed that the instrument acted regularly, and could be used as a damping manometer. It is possible to adjust the instrument so that a homogeneous scale is obtained with the highest sensitivities. The effects of vibrations of the supports, and of the radiometer effect due to the light which falls on the mirror for taking the readings, are considered. The observations of the Brownian movements are gone into, and the Boltzmann constants are calculated. H. N. A.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1692. X-Ray Protection. A. Bouwers and J. H. van der Tuuk. *Brit. J. of Radiology,* 3. *pp.* 503–514, *Nov.,* 1930.—A daily dose of 0·2*r* is accepted as the fundamental tolerance dose. A discussion of the photographic method for weak intensities is given, together with an estimation of the doses in *r* units which correspond to a blackening of 0·5 of a modern dupletized X-ray film. This dose is of the order of 0·02*r* for medium soft rays. The intensity which just permits the shadow of a lead strip on a fluorescent screen to be distinguishable in complete darkness with well accommodated eyes is found to give rise to a dose of 600*r* in 25,000 to 65,000 hours, according as the radiation is hard or soft. W. V. M.

1693. Ultra-Violet Glasses. A. R. Wood. *Brit. J. of Radiology,* 3. *pp.* 547–551; *Disc.,* 551–552, *Dec.,* 1930.—A brief account of the benefits derived from ultra-violet radiation and the importance of using ultra-violet transmitting glass for windows. Experiments carried out by the N.P.L. at Teddington on dull November days showed that wave-lengths as low as 3,050 Å. could be detected by visual examination of exposed plates; while on a day when there was a thick white fog, the shortest wave-length was 3,080 Å. The author draws attention to the errors caused by previous statements that exposure to the quartz mercury arc lamp for a short time would produce the same effect as prolonged exposure to sunlight. This statement is realised to be quite fallacious. The short wave-length radiation from the arc produces far greater deterioration than does the solar radiation. Glass which has been degenerated by exposure to the lamp when placed in sunlight recovers about half its transparency. The effect of dirt upon the glasses has been much exaggerated. It is only necessary to clean the windows when they are becoming opaque to visible light. High soda content tends to give high transmission of ultra-violet radiation, but it is liable to make the glass unstable so as to develop an iridescent film. In the *Discussion,* **B. Harmann** expressed his doubts as to the value of ultra-violet glass in London. W. C. S. P.

1694. Physical Characteristics of A.C. Therapeutic Carbon Arcs. R. A. Sawyer and C. W. Byers. *J.O.S.A.* 20. *pp.* 719–731, *Dec.,* 1930.—The characteristics of arcs used in ultra-violet therapy were studied from the point of view of the variation of arc length with voltage, and the relation between ultra-violet output and arc voltage and current. It was found that the voltage across the arc is approximately proportional to the arc length, a result in accord with those of other workers. The ultra-violet emission (measured by means of a cadmium cell in uviol glass) was found to vary with the voltage according to the law $U = K\sqrt{V - V_0}$, when K and V_0 are constants, U is the ultra-violet output and V the applied voltage, and to vary with current as given by the formula $U = C(I - I_0)$, when C and I_0 are constants and I the operating current. G. E. B.

1695. Secondary Electronic Emission from Metal Foils and Animal Tissues. W. V. Mayneord. *Roy. Soc., Proc.* 130. *pp.* 63–80, *Dec.* 2, 1930.—The paper describes experiments on small ionisation chambers artificially made sensitive to X- and γ-radiations by the insertion of foils of different elements. It is shown that compared to an air chamber these ionisation chambers show a maximum sensitivity in the region of medium wave-lengths. The theory of the occurrence of this maximum is discussed. A small ionisation chamber suitable for γ-ray measurements is described, and it is shown that the relative intensity of primary and secondary scattered beams of rays was differently estimated according to the materials of which the chamber was constructed. The experiments were extended to include the effects to be observed with ionisation chambers containing animal tissues. It is shown that again a region of maximum sensitivity is observed and that various tissues diverge by varying extents from " air equivalence." The significance of these observations is briefly discussed. AUTHOR.

1696. Modified Form of Radon Capillary Apparatus. H. H. Poole. *Roy. Dublin Soc., Proc.* 20. 1. *pp.* 1–6, *Dec.,* 1930. W. V. M.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

1697. Heats of Adsorption and Isotherms in the System Platinum-Hydrogen. E. B. Maxted. *Chem. Soc., J. pp.* 2093–2100, *Sept.*, 1930.—The differential heat of adsorption of hydrogen on platinum rises gradually with increase in the amount adsorbed until a maximum is reached beyond which further increase in the amount adsorbed is accompanied by decreasing values for the differential heat of adsorption. The sharpness in the maximum is dependent upon the " age " of the platinum preparation, becoming less pronounced the older the preparation. During the adsorption of hydrogen by platinum the bulk of the gas is adsorbed almost immediately, after which a relatively slow adsorption takes place which is not complete until several days have elapsed. "Ageing " decreases the adsorptive capacity of the platinum. It is suggested that the possession of a high adsorptive capacity and a high differential heat of adsorption are probably related to the possession of a high catalytic activity by the platinum. F. J. W.

1698. Interpretation of the Boedeker Adsorption Equation. L. Wöhler and W. Wenzel. *Kolloid Zeits.* 53. *pp.* 273–288, *Dec.*, 1930.—An extended application is made of the Boedeker equation $x/m = kc^{1/n}$, where x is the amount of solute absorbed by m gm. of solid from a solution which has a concentration c when the adsorption is complete: k and n are constants. The adsorption of acetic, propionic, butyric and valeric acids from aqueous solutions on charcoal is measured at temperatures of 20°, 40°, 60° and 80° C. The value of n rises, while that of k decreases as the temperature is increased. Adsorption of paraffin from solution in various hydrocarbon fractions on to charcoal is also studied. The adsorption of the paraffin is the smaller the higher is the boiling point of the solvent. The amount adsorbed is only slightly influenced by change of temperature. Adsorption of electrolytes from dilute aqueous solution is also investigated. In no case does the Boedeker equation fit the experimental results. The deviations are attributed to changes in the surface of charcoal due to the molecules already adsorbed and to the solvation of these molecules. F. J. W.

1699. Capillary Activity of Organic Substances in Aqueous Salt-Solutions. P. P. Kosakewitsch and N. S. Kosakewitsch. *Zeits. f. phys. Chem.* 150. *Abt. A.* 5–6. *pp.* 370–380, *Oct.*, 1930.—Normal solutions of lithium halides increase the capillary activity of phenol, *o*-cresol, thymol and menthol, the activities of the anions increasing in the order I′—Br′—Cl′ conforming to the normal lyotropic series. The surface-tension measurements were carried out, using v. Dallwitz-Wegner's modification of the capillary-rise method. Surface concentrations of the organic solutes are evaluated, using Gibbs' equation, and the resulting figures applied to Rideal's " equation of state " of the two-dimensional surface phase, *viz.*, $FA/RT = (B/RT)F + x$, in which F is the depression in the surface tension, A the area of the surface occupied by 1 gm.-mol. of the solute, and B and x are constants; the results are found expressible in this form, save in the case of menthol, which, owing to its low solubility, more probably exists in the form of an " expanded film." The activity of phenol is found to be the same as that derived from direct experiments on its adsorption to charcoal, and the approximate degree of hydration of lithium halides is computed from the results. L. V. C.

1700. Molecular Layers of Fatty Acids. A. Joffé and P. Lukirsky. *J. de Physique et le Radium*, 1. *pp.* 405–410, *Dec.*, 1930.—The potential fall at a molecular layer of stearic acid on a gold plate has been measured by means of ionisation caused by polonium placed at a suitable distance therefrom. The falls for layers one, two and three molecules thick were, respectively, + 0·13, 0, and + 0·09 volts, when the gold plate having been washed with pure water and dried in the air was necessarily covered with a film of moisture and so was of an alkaline character; when, however, it had been washed in acidulated water and then dried, the unimolecular layer gave a fall of – 0·14 volts. It is concluded that in the first layer the molecules of stearic acid are all attached to the plate by the same end of the chain, but by opposite ends, according as the plate was alkaline or acid, the next layer is attached to the first in the opposite way, while the third is arranged as the first. These results agree qualitatively with those of Guyot and Frumkin; possible causes of quantitative differences are discussed. C. A. S.

1701. Individuality of the Osmotic Coefficients of the Alkali Metal Halides. G. Karagunis, A. Hawkinson and G. Damköhler. *Zeits. f. phys. Chem.* 151. *Abt. A.* 5–6. *pp.* 433–466, *Dec.*, 1930.—An apparatus for the thermoelectric measurement of the depression of the freezing point of aqueous solutions is described; for solutions of concentrations lower than 0·1*M* the maximum variation amongst the results is 0·0002° C. The osmotic coefficients of potassium, rubidium, and caesium chlorides and fluorides, lithium and sodium fluorides, and sodium iodide at concentrations from 0·002 to 3 *M* have been determined, the concentrations being measured interferometrically. Whereas previous determinations exhibit variations amongst themselves comparable with the variations amongst the individual halides, the results obtained are sufficiently accurate for theoretical treatment. H. F. G.

1702. Swelling of Charcoal. Part I. Preliminary Experiments with Water Vapour, Carbon Dioxide, Ammonia, and Sulphur Dioxide. D. H. Bangham and N. Fakhoury. *Roy. Soc., Proc.* 130. *pp.* 81–89, *Dec.* 2, 1930.—The experiments of Meehan [see Abstract 2778 (1927)] having shown that charcoal increases in volume when taking up carbon dioxide, this expansion has now been correlated with the quantity of gas absorbed. For this purpose a form of extensometer has been devised and is described in detail which, while sufficiently sensitive and accurate for the measurement of the percentage linear expansion (x) of a rod of wood charcoal, was yet compact enough to permit of its being sealed up in an all-glass apparatus, so that simultaneous determinations could be made of the weight (s) of gas taken up per unit weight of the adsorbent. The expression obtained is $x = ks/(S - s)$, where k and S are constants. The values of the latter constant for the four gases examined represent nearly equal volumes of the normal liquids at the experimental temperature. The hypothesis is advanced that the expansion results from the pressure exerted by the adsorbed molecules at sharp re-entrant angles in the surface of the adsorbent. The expansion caused by the adsorption of a given quantity of gas increases with the temperature. H. H. Ho.

1703. Structure of Celluloid and Gelatinising Media for Nitrocellulose as Swelling Agents. Parts II, III and IV. J. R. Katz, J. C. Derksen, C. A. Kramers, K. Hess and C. Trogus. *Zeits. f. phys. Chem.* 151. *Abt. A.* 3–4. *pp.* 145–189, *Dec.*, 1930.—Part II.—The X-ray spectrum of celluloid without camphor consists of broad, ill-defined interferences, which, by comparison with nitrocellulose in the fibre form, are shown to be aggregates of fused, widened crystal interferences. By addition of camphor, the lattice of the nitrocellulose micelle is broken down owing to the formation of one or more camphor-nitrocellulose compounds, which give a characteristic X-ray spectrum. When celluloid strips are stretched, the interference rings are resolved into segments, this behaviour proving that the micelles of both the nitrocellulose and the compound exist in parallel formation. Part III.—Not only camphor, but other cyclic ketones, such as fenchone, carvone, menthone, etc., and cyclic alcohols, form compounds with nitrocellulose when used as gelatinising agents. Part IV.—Acid amides and esters of carboxylic acids behave similarly, and as these and the above substances all contain a carbonyl group in the molecule, it seems probable that combination with the nitrocellulose is effected by way of the residual valency of this group. [For Part I see Abstract 642 (1931).] T. H. P.

1704. Changes in Volume and Temperature Accompanying Mixing of Organic Liquids. Part I. E. R. Washburn and A. Lightbody. *J. Phys. Chem.* 34. *pp.* 2701–2710, *Dec.*, 1930.—The changes in volume and temperature which occur on mixing the following pairs of liquids are determined for the complete range of concentration: benzene with methyl alcohol, ethyl alcohol and isopropyl alcohol, and acetone with the same alcohols. There is no simple relationship between the temperature changes and volume changes for these solutions, but on ascending the homologous series of alcohols with benzene and with toluene the maximum temperature changes become greater for mixtures of corresponding concentration. The volume changes also vary in a regular manner. Water has a pronounced effect on the changes in the mixtures of ethyl alcohol and benzene. A. J. M.

1705. Liquid Ammonia as a Lyophilic Dispersion Medium. R. Taft. *J. Phys. Chem.* 34. *pp.* 2792–2800, *Dec.*, 1930.—The qualitative dispersibilities of over 100 colloidal materials in liquid ammonia have been examined. This liquid forms an excellent dispersion medium for certain starches, cellulose esters, dyes of high molecular weight, and a few proteins. It does not disperse gums or resins, most proteins and soaps. The views of Ostwald upon the colloidal character of liquid ammonia solutions of alkali metals and of sulphur are not supported by the present experimental knowledge of these systems. A. J. M.

1706. Distribution of Ions in Gels. E. J. Bigwood. *Faraday Soc., Trans.* 26. *pp.* 704–719; *Disc.*, 719–723, *Dec.*, 1930.—The object of this report is to show that there is experimental evidence of the fact that when an aqueous gel exchanges electrolytes and water with a true aqueous solution in which it is immersed and when an equilibrium of diffusion is reached between both phases, the chemical constituents of the gel may be unevenly distributed within the colloidal phase. The two following conditions must be fulfilled: (*a*) rigidity must be one of the properties of the colloidal phase, showing evidence of an internal structure in the latter;

(*b*) the material which enters into the constitution of the gel structure must be capable of reacting chemically with the diffusing electrolyte and hence be capable of swelling or synæresis. Gelatin gels fulfil both conditions; agar gels do not. In the *Discussion*, **F. G. Donnan** said that Bigwood's work pointed to the existence of a hitherto unsuspected class of phenomena, which were in all probability of great biological importance, *viz.*, the occurrence of stationary ionic gradients in a gel system possessing a stationary micellar gradient. **G. S. Adair** dealt with a formula for the depth of penetration of electrolytes into gels, and **A. T. King** pointed out that wool keratin shows somewhat similar behaviour to gelatin in that residual acidity persists in contact with excess of alkali carbonate at low concentration. H. H. Ho.

1707. Hydrosol of Silicic Acid. Part I. Hydrosol Made from Ethyl Silicate by Hydrolysis. Part II. Electrical Properties. K. Inaba. *Inst. Phys. and Chem. Research, Sci. Papers No.* 278. *pp.* 1–15, *and No.* 279. *pp.* 16–31, *Dec.* 20, 1930.—Part I.—Silicic acid hydrosol prepared by hydrolysis of ethyl silicate in presence of a small amount of hydrochloric or sulphuric acid cannot be purified completely by electrodialysis, as it begins to coagulate when the acid concentration is reduced to about $0 \cdot 0002\,N$; it is stable in presence of $0 \cdot 01$–$0 \cdot 02\,N$ acid and is termed "acid sol." The sol similarly prepared in presence of alkali hydroxide can be freed completely from alkali without coagulating and is stable in a neutral medium; this is termed "neutral sol." The acidic sol exhibits lower electrical conductivity and greater viscosity than the neutral sol. The latter is readily converted into a sol like the acidic one by addition of hydrochloric acid, the stability of the sol thus obtained, as well as that of the acidic sol itself, being greatly influenced by the concentration of the acid. Part II.—Measurement of the migration velocities of the neutral and acidic sols, and of those obtained from silicon tetrachloride by hydrolysis and from sodium metasilicate and hydrochloric acid shows that the acidic sol has a low degree of dispersion, the migration velocity and the particle charge being small. The hydrosol dialysed from neutral or alkaline solution shows a high degree of dispersion and a high migration velocity. When hydrochloric acid or a neutral salt, such as potassium or barium chloride, cerium trichloride, or thorium tetrachloride, is added to the neutral sol, the silica particles adsorb kation from the electrolyte and the migration velocity decreases gradually without coagulation until the isoelectric point is passed and the direction of migration reversed. The sols containing barium chloride or cerium trichloride are exceptions, being unstable in alkaline solution. As electrolyte is added, the viscosity changes and has a minimum value in the neighbourhood of the isoelectric point. It is deduced that the charge of the acidic solution is due mainly to the chlorine ions adsorbed from the medium, and that of the neutral sol to the silicate ions. T. H. P.

1708. Properties of Pure Nickel. L. Jordan and W. H. Swanger. *Bureau of Standards, J. of Research*, 5. *pp.* 1291–1307, *Dec.*, 1930.—Rather pure electrolytic nickel was further purified by annealing in hydrogen. A study was made of suitable refractory crucibles and of melting conditions to produce extremely pure compact metal. The ingots finally prepared were of a purity of 99·94 %. New determinations of many of the physical properties of nickel have been made on the very pure metal thus made available. Data are given on density, crystal-lattice constant, melting point, electrical resistivity, magnetic properties, thermal e.m.f., thermal expansion, hardness, tensile strength, and reflectivity. AUTHORS.

1709. Diffusion of Salt Ions in Aluminium. J. Cichocki. *Comptes Rendus*, 191. *pp.* 841–842, *Nov.* 10, 1930.—A tube of aluminium is filled with $NiCl_2$ and drawn out to a fine wire. This is placed along the axis of an evacuated copper tube with a p.d. between them. When the aluminium is heated electrically to 600° C., a photoelectric emission is observed, which is entirely positive and rises to a maximum after 1 hour. This is attributed to absorption of the salt by the metal, which reaches a maximum and then decreases through the effect of emission of ions into the vacuum. C. B. A.

1710. X-Ray Study of Grain Size in Steels of Different Hardness Values. W. A. Wood. *Phil. Mag.* 10. *pp.* 1073–1081, *Dec.*, 1930.—The mathematical investigation of Laue of the effect of particle size on the breadth of X-ray interference lines is applied to the case of samples of steel of different hardness values. The method of measuring the half-breadths of the iron lines by the Moll microphotometer is described. A relation is found to exist between the measured half-breadths and the hardness numbers of the respective steels. From the half-breadths the grain size of the steels is determined with the aid of Laue's equations. The relation between the grain size and the hardness is discussed, the relation being found to agree with the assumption that the hardness varies inversely as the superficial area of the grains. AUTHOR.

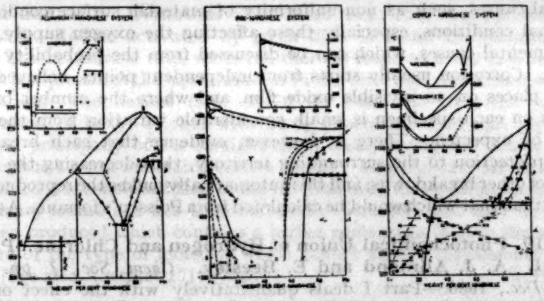
1711. Alloys of Zinc and Manganese. N. Parravano and V. Montoro. *Accad. d'Italia, Mem.* 1. (*Chim.*) 4. [19 *pp.*], 1930.—In 1915 one of the authors (N. Parravano) had announced the production of two compounds of zinc and manganese, containing respectively 10·73 and 21·88 % of manganese. These results were denied from Tammann's laboratory; it was alleged that there were only mixed crystals; and Gieren confirmed this. Then Akermann took up the question, and declared against the production of mixed crystals; he obtained Parravano's 10·73 % product, but believed it not to be $MnZn_7$, as Parravano had made out, but a mixture of $MnZn_9$ and $MnZn_6$. The authors have resumed inquiry, using the method of examination by means of X-rays. They find that on successive increments of manganese the products pass through phases as follows: a phase with a hexagonal reticulum, that of zinc, up to 0·98 % Mn, a solid solution of manganese in zinc; a phase with again a hexagonal reticulum but of a different type from that of zinc, and corresponding to $MnZn_7$ with 16 atoms ($2MnZn_7$) in each cell; and a third phase, centred cubical network, corresponding to $MnZn_3$, with 48 atoms ($12MnZn_3$) in each cell. A. D.

1712. X-Ray Investigation of the Lead-Antimony Alloys. D. Solomon and W. M. Jones. *Phil. Mag.* 10. *pp.* 470–475, *Sept.*, 1930.—Powder photographs have been taken of pure antimony, lead and alloys containing 70 % antimony to 30 % lead and 80 % lead to 20 % antimony. The spacings of antimony and lead in the alloys were the same as those in the pure metals. It is therefore concluded that the solid solubility of antimony in lead or of lead in antimony must be less than 0·5 % at room temperature. F. J. W.

1713. Use of Bismuth in Fusible Alloys. *Bureau of Standards, Circ.* 388. [10 *pp.*], 1930.—Bismuth is an essential constituent of most of the readily fusible alloys. Consequently a study of these alloys was undertaken as part of an investigation seeking to develop and extend the uses of metallic bismuth. The literature and uses of fusible alloys are reviewed in this paper. Two, three, and four component fusible metals are discussed. Tables of fusible alloys are given, and the question of volume changes in the alloys during and after solidification is discussed.

1714. Heat of Mixture of Molten Metals. M. Kawakami. *Tohoku Univ., Sci. Reports,* 19. *pp.* 521–549, *Dec.,* 1930. *In English. Report No.* 256 *from the Research Inst. for Iron, Steel and other Metals.*—In the same way as in the previous experiment [see Abstract 1751 (1928)] the heat of mixture was measured for twenty-five systems of binary alloys which contain as the one component, magnesium, antimony, aluminium, silver, copper or gold. The results confirm the conclusion arrived at in my previous investigation that intermetallic compounds which exist in the solid state up to their melting points do not decompose into their components in melting, but exist as such in the liquid phase. Some of the results are compared with the values obtained by calculation from either volume change with van Laar-Lorenz's equation or e.m.f. measured by N. Taylor and are found to agree fairly well with those calculated. A theoretical formula for the heat of formation of solid solution from solid components has been derived from the standpoint of thermodynamics, by means of which the heat of formation for several alloys is found to be endothermic. AUTHOR.

1715. Equilibrium Diagrams of the Aluminium-Manganese, Iron-Manganese and Copper-Manganese Systems. T. Ishiwara. *Tohoku Univ., Sci. Reports,* 19. *pp.* 499–519, *Dec.,* 1930. *In English.*—



The diagrams reproduced are obtained using aluminium containing 99·5 % Al, manganese containing 96–98 % Mn, electrolytic copper and iron. A. J. M.

1716. Theory of Regular Mixed Phases. C. Wagner and W. Schottky. *Zeits. f. phys. Chem.* 11. *Abt. B.* 2–3. *pp.* 163–210, *Dec.,* 1930. —Regular mixed phases of binary systems are characterised by the fact that each of the two components is present in the form of a part lattice of the crystal. The present comprehensive paper deals with the subject under the following headings: (1) discussion of problems; (2) models for the representation of regular mixed phases; (3) derivation of equations for the chemical potentials and activities of the components; (4) general thermodynamic applications; (5) change of lattice constant with composition; (6) change of specific electrical resistance of metallic mixed phases with composition; (7) further application possibilities of defective arrangements; (8) examples of mixed phases with defective arrangements, *e.g.*, uranium oxide; (9) calculations: (*a*) general, (*b*) the γ'-phase of the system iron-nitrogen, (*c*) intermediate crystal species in the system mercury-zinc, (*d*) the system gold-mercury, (*e*) the mixed phase Au-Cu. H. H. Ho.

1717. Solution of Metals in Acids. G. Walpert. *Zeits. f. phys. Chem.* 151. *Abt. A.* 3–4. *pp.* 219–233, *Dec.*, 1930.—The solution of metals in acids with the addition of salts, acids and substances with high molecular weights was investigated. The volume of gas evolved was used as a measure of the reaction, together with potential measurements which indicated the constancy of the end conditions. The rate of solution of iron in 8N . HCl was decreased by the addition of sulphuric acid. The solution velocity in concentrated sulphuric acid was reduced by the halogens. It was greatest for iodine and least for chlorine. The velocity of solution was reduced by the addition of aliphatic acids. The order of reduction was: formic, acetic, propionic, butyric. Materials with a high molecular weight such as gelatin and methyl violet exerted a great reduction in the rate of solution. In dilute solutions the addition of salts had little influence on the rate of solution. The action of the various substances was considered to be due to adsorption. F. J. B.

1718. Reproducibility in Corrosion Work. U. R. Evans. *Am. Electrochem. Soc., Trans.* 57. *pp.* 407–417, 1930.—Lack of agreement between two " identical " corrosion experiments may be due (1) to experimental causes, such as non-uniformity of material, surface condition or external conditions, especially those affecting the oxygen supply, (2) to fundamental causes, which can be discussed from the probability standpoint. Corrosion usually starts from independent points, believed to be weak places on an invisible oxide film, and where the number of these points on each specimen is small, considerable variation from the mean is to be expected. There is, however, evidence that each breakdown gives protection to the surrounding territory, thus decreasing the probability of other breakdowns, and this automatically makes the reproducibility better than that which would be calculated from Poisson's formula. AUTHOR.

1719. Photochemical Union of Hydrogen and Chlorine. Parts I and II. A. J. Allmand and E. Beesley. *Chem. Soc., J. pp.* 2693–2721, *Dec.*, 1930.—Part I deals quantitatively with the effect of light intensity. With monochromatic light of wave-lengths 405 $\mu\mu$ and 436 $\mu\mu$, the rate of union was proportional to the intensity over measured intensity ratios of about 180 : 1 and 440 : 1 respectively. With plane-polarised complex light, the same relation held over a measured intensity ratio of 4 : 1. An explanation is offered of the divergent results obtained earlier by Baly and Barker [see Abstract 1741 (1922)]. Using intermittent monochromatic light of wave-lengths 313 + 303, 365, 405 and 436 $\mu\mu$, and of quantitatively measured intensity, the rate of reaction was found proportional to the average light intensity, and independent, within the limits employed, of the rate of intermission. Part II studies the quantum efficiency of the reaction as a function of wave-length between the limits of 260–546 $\mu\mu$. It was found to pass through a maximum in the violet, falling off towards the green and the ultra-violet. The threshold of the reaction lies to the long wave-length side of 546 $\mu\mu$. The temperature coefficient of the quantum sensitivity as experimentally found increases with increasing wave-length between the limits of 313–436 $\mu\mu$. The sum of the effects of two monochromatic rays acting successively is found to be equal to this total effect when acting simultaneously. H. H. Ho.

1720. Thermal and Photochemical Decomposition of Ozone. H. J. Schumacher and G. Sprenger. *Zeits. f. phys. Chem.* 11. *Abt. B.* 1. *pp.* 38–44, *Dec.*, 1930.—The objections of Riesenfeld and Wassmuth to the conclusions of a previous paper by the authors [see Abstract 2695 (1930)] are discussed and rejected. It is shown that a chain theory in the form proposed by Riesenfeld and Wassmuth leads to great difficulties. H. H. Ho.

1721. Photochemical Reaction between Ethylene Iodide and Iodine in CCl_4 Solution. H. J. Schumacher and E. O. Wiig. *Zeits. f. phys. Chem.* 11. *Abt. B.* 1. *pp.* 45–55, *Dec.*, 1930.—The photochemical reaction between ethylene iodide and iodine in solution in CCl_4 is investigated, and an equation derived to express the velocity of the reaction. It is found to be a chain reaction, and its temperature coefficient at 100° C. is found to be 1·57 for 10°. The equation for the velocity of reaction is obtained from the following stages of the reaction: $I_2 + E \rightarrow I + I$; $I + C_2H_4I_2 \rightarrow C_2H_4I + I_2$; $C_2H_4I \rightleftarrows C_2H_4 + I$; $I + I \rightarrow I_2$. F. J. B.

1722. Separation of the Two Types of Iodine Molecule and the Photochemical Reaction of Gaseous Iodine with Hexene. R. M. Badger and J. W. Urmston. *Nat. Acad. Sci., Proc.* 16. *pp.* 808–811, *Dec.*, 1930.—Iodine activated by green light is found to combine with hexene at a reasonable rate, while the thermal reaction is not troublesome since at low pressures the equilibrium is in the direction of almost complete dissociation. The hexene (b.p. 68–70° C.) used was prepared by the dehydration of hexyl alcohol with 80 % phosphoric acid and probably consisted principally of the straight-chain form having the double band between the second and third carbon atoms. Experiments are described from which it is concluded that in the reaction tube the equilibrium existing in ordinary iodine gas has been materially disturbed, and that an iodine has been produced which contains a higher percentage than in the normal mixture of the type of molecule which cannot absorb the mercury green line. [See also Abstract 2719 (1928).] H. H. Ho.

1723. Lattice Energies of Silver Halides and Their Photochemical Decomposition. Part II. S. E. Sheppard and W. Vanselow. *J. Phys. Chem.* 34. *pp.* 2719–2748, *Dec.*, 1930.—This paper continues a previous investigation [see Abstract 2311 (1929)] and affirms the importance of lattice energy for light absorption and photo-decomposition of crystals. The application of Sommerfeld's "electron-gas" theory of metals to photo-ionisation in ionic crystals (polar lattices) is discussed and criticised. Pauling's conception of an "electron affinity of the crystal," based on the electron gas theory, is analysed, and certain objections raised. Replacements of "the electron affinity of the crystal" by the virtual field (lattice potential) of the metal released by photo-ionisation is suggested as giving better concordance of observed and calculated wave-length limits of absorption. It is suggested that deformation of anions by kations with large external electron sheaths tends, *per se*, rather to shorten the wave-length limit of light absorption than to extend it. Adsorption effects supporting the opposite view are ascribed to lattice loosening. H. H. Ho.

1724. Ignition of Hydrogen-Oxygen Gas by Electric Sparks. A. Kowalsky. *Zeits. f. phys. Chem.* 11. *Abt. B.* 1. *pp.* 56–58, *Dec.*, 1930.—The ignition of mixtures of $2H_2 + O_2$ by electric sparks was studied. A lower limit of pressure was found, below which no ignition took place. Increase in the strength of the spark or rise of temperature lowered the limit by a definite amount. The lower limit of spontaneous ignition at 450° C. and that of ignition by the spark were found to be in agreement. F. J. B.

1725. Ammonia Discharge Tube. G. I. Lavin and J. R. Bates. *Nat. Acad. Sci., Proc.* 16. *pp.* 804–808, *Dec.*, 1930.—A preliminary study is described of the gases flowing from the exit of an ammonia discharge tube, where the active gas appears to consist of atomic hydrogen and NH or NH_2. Catalytic effects of certain substances and characteristic luminescences at various surfaces have been observed and are discussed. The inability of hydrogen atoms or molecules to react with NH_x on a surface of zinc catalyst is of interest in relation to the results of Taylor and Lavin, who showed it to be extremely effective in removing hydrogen atoms, and suggests that zinc oxide catalysts may not be efficient in the recombination of hydrogen and —OH. H. H. Ho.

1726. Spectroscopic Study of the Decomposition and Synthesis of Organic Compounds by Electrical Discharges. Part I. The Electrodeless Discharge. W. D. Harkins and D. M. Gans. *Am. Chem. Soc., J.* 52. *pp.* 5165–5175, *Dec.*, 1930.—The electrodeless discharge in benzene, acetylene, naphthalene, *n*-heptane, aniline, nitrobenzene, phenol and chlorobenzene has been studied spectroscopically. The spectra indicate that these organic vapours are decomposed into simpler molecules, atoms and ions. Benzene, acetylene and naphthalene give as decomposition products, (CH), (C_2), (C), (C^+) and hydrogen atoms. Phenol gives in addition the molecular species (OH), (H_2O) and (CO). These decomposition products are very reactive chemically and unite to form brown or black solids which are insoluble in water and organic solvents. The spectrum of the discharge in *n*-heptane indicates decomposition to (H), (CH) and (C), but little subsequent polymerisation occurs. F. J. W.

1727. Atomic Reactions Showing Inertia. H. v. Hartel and M. Polanyi. *Zeits. f. phys. Chem.* 11. *Abt. B.* 2–3. *pp.* 97–138, *Dec.*, 1930.—The fundamental significance of the many reactions in which free atoms react with molecules in absence of inertia is revealed by London's theory of the heat of activation and is very generally supported by consideration of the laws of valency. Such consideration does not justify the assumption of complete absence of inertia, but indicates that, in atomic reactions, the inertia is usually relatively low, corresponding mostly with a heat of activation less than 15 kg. cal. The reactions considered are those of sodium vapour with organic halogen compounds, and these show regular gradations of the inertia of reaction. Such reactions, in which a halogen atom is split off and the free radical thus formed, are accompanied by but slight or no luminescence. A new method of investigation has, therefore, been developed, the penetration of the sodium vapour into that of the other reacting substance, taken as the measure of the velocity of reaction, being followed by rendering the sodium vapour visible in the light of a resonance lamp. T. H. P.

1728. Cadmium-Lead Chloride Voltaic Cell. R. J. Priepke and W. C. Vosburgh. *Am. Chem. Soc., J.* 52. *pp.* 4831–4837, *Dec.*, 1930.—A series of careful measurements was undertaken in order to investigate the discrepancies in the published voltages for the cadmium-lead chloride cells. Cells were made up of carefully purified materials, and precautions were taken to obtain definite hydrates of cadmium chloride. The cells studied were: (1) $Cd(Hg)/CdCl_2 2{\cdot}5H_2O(sat.)/CdCl_2 2{\cdot}5H_2O(sat.), PbCl_2/Pb(Hg)$; (2) $Cd(Hg)/CdCl_2 2{\cdot}5H_2O(sat.)/CdCl_2 2{\cdot}5H_2O(sat.)Hg_2Cl_2/Hg$; (3) $Pb(Hg)/PbCl_2(sat.)/PbCl_2(sat.), Hg_2Cl_2/Hg$. The values obtained for cell (1) were in good agreement with that obtained by Obata, 0·1408 volt when the hemipentahydrated cadmium chloride was used. When the monohydrated cadmium chloride was employed the values obtained were in agreement with those found by Vosburgh, 0·13859 volt at 25° C. The temperature coefficients of the cells were measured. Cell (3) was the most difficult in which to reproduce exact measurements of the voltage. F. J. B.

1729. Electrode Potentials of Silver in Cyanide Solutions. C. G. Fink and G. B. Hogaboom, Jr. *Am. Electrochem. Soc., Trans.* 57. *pp.* 99–106; *Disc.*, 107–111, 1930.—Polarisation potentials heretofore recorded for silver in silver cyanide-sodium cyanide solutions have varied widely. Accepted "standard" methods for determining polarisation values have given discordant results. The authors therefore investigated the behaviour of solid silver plate electrodes, and found that the polarisation potentials are highest near the upper edge of the square plates and lowest near the lower edge. The difference in values obtained is attributed to the behaviour of the solution film next the electrode surface. Uniformly consistent polarisation potential values seem possible only when the surface film is of uniform composition and structure throughout. AUTHORS.

1730. Determination of Absolute Potentials. J. Billiter. *Am. Electrochem. Soc., Trans.* 57. *pp.* 351–360, 1930.—The various methods proposed and used in the past for the determination of the absolute potentials are reviewed and discussed at length. The more recent methods based on the production of fresh metal surfaces give a more reliable value ($\epsilon_H = + 0{\cdot}475$ volt) which fits in better with our modern physical and chemical conceptions. The older value ($\epsilon_H = - 0{\cdot}277$ volt) is shown to be out of harmony with these conceptions. Experiments are recorded to show that the older methods ($\epsilon_H = - 0{\cdot}277$ volt) are misleading. The new scrape method of Bennewitz is recommended as being the most trustworthy one ($\epsilon_H = + 0{\cdot}475 \pm 0{\cdot}005$ volt). AUTHOR.

1731. Potential of the Iridi-Iridochloride Electrode. H. Terrey and H. C. Baker. *Chem. Soc., J. pp.* 2583–2586, *Dec.*, 1930.—Measurements of the potential of the iridi-iridochloride electrode at 25° C., using electrodes of iridised iridium foil welded to platinum-iridium wire or of iridised glass, show that the e.m.f. varies according to the equation, $E = E_0 + RT/F \, . \log_e i/o$. From determinations of the temperature coefficient of the cell, the heat of oxidation of iridochloride is calculated to be 5600 cals., the heat of formation of calomel being taken as 31,300 cals. [See Abstract 1415 (1928).] T. H. P.

1732. Model to Explain the Mechanism of Electrolysis. M. deK. Thompson. *Am. Electrochem. Soc., Trans.* 57. *pp.* 345–348; *Disc.*, 349, 1930.—A model is described which illustrates the mechanism of electrolysis, showing the following: (1) that there is no change in the middle portion; (2) that the solution remains electrically neutral at the electrodes (3) that the loss at the anode is proportional to the velocity of the kation, and the loss at the kathode is proportional to the velocity of the anion. This is done for three different relative velocities of anions and kations. AUTHOR.

1733. Diaphragm Electrolysis. F. Giordani. *Accad. d'Italia, Mem.* 1. (*Chim.*) 6. [75 *pp.*] 1930.—This is a substantial little treatise in which the whole subject of electrolysers with a filtering diaphragm is worked out in the light of recent discoveries concerning the conductometric behaviour of concentrated solutions of strong electrolytes. Formulæ sufficiently approximate are arrived at from a consideration of inter-ionic forces. The paper covers not only the electrolysers with counter-current, but also the simple diaphragm with stationary liquids. The paper is full of applications of the theory to practical cases. There is also a good Bibliography. A. D.

1734. Colloidal Diaphragm for Electrolysis of Water. G. F. Jaubert. *Comptes Rendus*, 191. *pp.* 1447–1449, *Dec.* 29, 1930.—When a 25 % solution of potassium hydroxide holding in colloidal suspension a hydrogel such as calcium magnesium silicate (colloidal asbestos) or calcium or ferric hydroxide is electrolysed with a nickel anode and iron kathode, there is deposited on the anode a uniform layer several mm. thick of the colloidal material. This requires several hours or days according to the fineness of the suspension. If iron wire gauze be placed between the electrodes such a deposit accumulates thereupon instead of on the anode, and this in the course of about 50 hr. becomes absolutely impermeable to the free gases evolved by the electrolysis. Such a diaphragm is very cheap, possesses very low resistance, and enables hydrogen of 100 % and oxygen of 99·5 % (0·5 % hydrogen) purity to be readily prepared. C. A. S.

1735. Electrochemical Investigations on Aluminium and Aluminium-Mercury Alloys. H. Gerding. *Zeits. f. phys. Chem.* 151. *Abt. A.* 3–4. *pp.* 190–218, *Dec.*, 1930.—The system aluminium-mercury, which forms no compounds, exhibits two phases from 0·8 to 99·97 % of Hg. Extrapolation of the e.m.f.-composition curve for aluminium amalgams dissolved in acetylacetone indicates that the potential of active aluminium is — 0·130 volt compared with that of the two-phase amalgam. The normal potential of perfectly activated aluminium is not known with great accuracy, but it is probably not much more positive than — 1·43 volt in aluminium sulphate solution or than — 1·47 volt in aluminium chloride solution. The electrochemical behaviour of aluminium and of aluminium amalgams in acetylacetone solution is not explainable by the formation of a film of oxide. A clean amalgam surface exhibits a limiting wave-length somewhat greater than that of aluminium. The above results are in accord with the theory which accounts for passivity by a difference in the metal itself. T. H. P.